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Management Plans

with Special Reference to

The National Forests

By

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Forest Service

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MANAGEMENT PLANS: WITH SPECIAL REFERENCE TO THE NATIONAL FORESTS

By INMAN F. ELDREDGE, *Forest Inspector, Branch of Forest Management, Forest Service*

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INTRODUCTION

Forest management in America is gradually acquiring a character and color of its own. For many years foresters in this country were forced, because of lack of American experience, to preach and practice methods transplanted bodily from Europe. But when a background of actual practice and a better understanding of the silvicultural and economic factors peculiar to this country had been acquired, there came about a general realization that we could not begin where Europe left off; that we must, to a certain degree at least, meet American conditions with American measures.

Basic principles of forest management developed in Europe after centuries of trial hold as true in this country as they do abroad; it is in the application of these principles to our very different circumstances that the need and the opportunity for adaptation and invention have arisen. The appreciation of this fact has had a stimulating effect; and, freed for the time from the constraint of strict conventionality, foresters all over the country have been making marked

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progress in developing methods of management fitted to American economic and silvicultural conditions.

In this publication is presented a general exposition of one phase only of forest management—the making of the plan, and that mainly as it relates to the national forests. While the primary purpose of the bulletin is to aid national forest officers who are charged with the responsibility of making or carrying out management plans, it is hoped that the treatment of the subject will be of interest to foresters generally.

MANAGEMENT PLANS IN GENERAL

Timber is a long-time crop. To grow a stand of timber to merchantable size from seed takes a century or more and requires the work of a long succession of forest managers. It would be futile for short-lived man to attempt to grow a crop that outlives him by so many decades if the progress of the project were left to the expediency of the moment or to the whims of the successive individuals in authority. While individual managers, each as his turn comes, must accept full responsibility for the details of application, and while there must be given to each man great leeway for the exercise of judgment, initiative, and skill, the project can not be a success in the end unless all hold in common the same vision and carry forward through the successive stewardships the same purposes and policies.

The complexity of the situation is easily appreciated when it is realized that, nearly always in the national forests, the forester has in the territory under his charge a dozen or more timber crops in all stages of development from seedling to sawlogs, in all shades of condition from thrifty to decadent, and all affected more or less by conflicting silvicultural needs and by inaccessibility, inferior species in admixture, poor or fluctuating markets, insect depredations, and fire losses.

Without a definite plan it is virtually impossible for a succession of foresters, no matter how well equipped they may be individually, to manage intelligently and successfully over a long period of years the timber resources of a forest region. On every national forest all of the more important phases of work are guided and controlled through the use of plans and schedules. There are grazing plans, whose purpose it is to bring about systematic and profitable use of the forage; there are improvement plans, road plans, protection plans, land-exchange plans, and work plans, all of which represent steps toward systematizing and coordinating the work of the service, to the end that its effectiveness may be increased and that continuity of action, so essential in any large project, may result.

A management plan, as the term is used in the Forest Service and in this publication, concerns and is confined to the development and the disposition of the timber crop, and differs from a working plan in that it does not cover, in planwise fashion, forest planting, protection, grazing, improvement, and general administration. These important phases of forest work are all taken into account in the preparation of a management plan but only so far as they are related to the treatment and marketing of the timber crop.

WHAT THEY CONTAIN

Usually a national forest as a unit is too large and exhibits too great a complexity in conditions to permit of management of its timber resources under one plan; it must be divided into smaller areas or working circles in which the conditions of timber growth and utilization are more susceptible of analysis and appraisal. Management plans are made for working circles; and for these areas they set out a description of the area, the timber, and the economic situation; a delineation of the objects of management; a statement of the policies of the administration in handling the timber resources; a determination of the amount of timber to be cut, the period in which it is to be cut, and the manner in which sale areas will be located; and, finally, a budget or list of those specific areas from which timber is to be sold during a given period, usually 5 or 10 years. Such plans, while brief and simple in their treatment and as specific as possible in prescriptions for action, do not attempt to give in detail the action to be taken by the forest supervisor in the conduct of his timber business. Only the controlling essentials, the high spots as it were, are touched upon.

THE PERIOD COVERED

Economic developments in the national forests generally are occurring so rapidly that conditions can not be foreseen with enough clearness and confidence to justify the making of definite provisions for cutting for a full rotation ahead or for even a considerable part of one. It is to be expected that utilization policies and plans will have to be changed as the situation changes, and it is not practicable to attempt commitment, except in regard to general policies, for more than a very few decades in advance. Even in the most intensively managed working circles in the national forests the cutting budgets are seldom made to cover a period of more than 10 years, and they are frequently made for a 5-year period. Where the entire cut of a working circle is taken by one or two operators under long-time contracts, the situation is much simplified and action can be planned with considerable definiteness for a longer period.

PERIODIC REVISION

The periodic revision of the cutting budget and the occasional overhauling of the expression of the policies are necessary in order to keep the plan alive, in tune with circumstances, and practicable of application. Better data on growth and volume, or changes in marketability, may force revision. Except in the case of false premises or of a failure to appraise the situation correctly in the original plan, periodic revision should not change the general course of management; the main objects of management are carried forward intact as are the major policies of the administration.

MUST BE PRACTICABLE

A management plan must stand two rigid tests—one as to its technical soundness from the standpoint of long-time management—that is, whether it can produce the desired results in the long run;

the other as to the practicability of its application. No matter how clear the vision of the maker of the plan, no matter how logical and technically sound are his prescriptions, his plan will remain only a literary effort if it can not be put into action in the woods through the medium of the lumberman's ax and saw.

BUSINESS JUDGMENT MUST ENTER

Nor should the forester who is planning his timber management underestimate the extent to which sound business judgment must enter into and color his findings. The harvesting of the mature crop is not solely a silvicultural operation, it is a commercial transaction as well. Here he enters the commercial field and must plan his actions with an understanding of the customs and the rules of the business world. In the allocation of his cut to specific areas and to certain periods of time it is not only his opportunity, but his responsibility, to exercise a high quality of salesmanship in order that he may get for his product its full value in dollars and cents, and in order that he may bring the weight of legitimate business strategy to bear on the buyer to take the forest's offerings as budgeted.

WHEN NEEDED

It is not a difficult matter to decide when a management plan is needed for a given working circle; the decision is based wholly on common sense. In general, it might be said that a plan is not needed unless and until it is possible to put the prescriptions of a plan into action. There are some exceptions to this rule of thumb but not many. A working circle remote in location and time from active demand by lumbermen rarely needs a management plan. One whose resources are being used to such a small extent that the drain upon it does not represent anything approaching the sustained yield possibility will need a management plan only when the nature of the business that does exist threatens to complicate the situation for future utilization, or when the situation seems ripe to try for a much larger business. It goes without saying that a management plan is needed in all working circles that are shortly to be opened up for utilization on a scale commensurate with their resources and possibilities.

WHO SHOULD MAKE THEM

Naturally, since a management plan is a serious commitment to a definite line of action over a considerable length of time, it should be made by the man most familiar with all angles of the situation. In the Forest Service this is usually the forest supervisor. It is vital to the success of a plan that it represent something that can be done. No other man is as well equipped to contribute the element of practicability as the supervisor; for he knows the limitations imposed and the opportunities afforded, on the one hand by the calls on the time of his force and on their training and capacity for timber work, and on the other by the character, needs, and tendencies of the people and industries that the forest is to serve and that must be depended upon for a market.

While, of course, he will employ members of his force and such other assistance as he needs or can get in making an inventory and

maps, collecting growth and yield data, and arriving at an appraisal of the economic situation, the supervisor, himself, must bring his judgment into play in drawing up the plan of action to which he is to commit the working circle. A plan of action that is the child of his brain will naturally receive a much more enthusiastic support from the supervisor than any plan that is handed to him from above. By the same token the interest of that "ultimate producer," the district ranger, is enlisted largely in proportion to his participation in the making of a plan which involves part or all of his district. It may be expedient at times to have a district office man or a subordinate on the supervisor's staff draw up a plan without participation on the part of the supervisor, but it must be recognized that in so doing an element of weakness is introduced that may seriously cripple the plan.

AN AID TO ADMINISTRATION

Though the managing forester is definitely committed under a management plan to certain outstanding objectives and policies, and, for a shorter period, to certain definite lines of action, the general effect of the plan is not cramping or restrictive. On the contrary, it leaves him free to exercise all the initiative, all the business ability, and all the professional skill at his command. In his administration it gives him the security that comes of traveling a charted course and the confidence and strength that springs from a knowledge that the action proposed has been approved in advance by those officers above him to whom he must look for support.

THE PREPARATION OF MANAGEMENT PLANS

In preparing a management plan for a working circle the problem is attacked somewhat in this order:

1. Divide the forest into working circles.
2. For the working circle concerned obtain and assemble all pertinent data and maps for study and analysis from every angle.
3. Decide on the objects of management.
4. Determine the silvicultural system or systems to be used.
5. Calculate the yield.
6. Formulate the policy to govern the timber-sale business.
7. Choose the areas from which the timber is to be cut during the first cutting period and list them in budget form.
8. Present the plan in the form of a concise report accompanied by maps and pertinent data.

DIVISION INTO WORKING CIRCLES

The average national forest, including as it does about a million acres, does not lend itself readily to timber management under a single plan. The diversity of topographic, silvicultural, and economic conditions, and the number and complexity of the various influences that affect the growth and the utilization of the timber in such a large area, are almost certain to defeat all attempts to visualize the situation and reduce the problem to its fundamentals. A plan covering a whole forest would be either so vague and generalized in its provisions as to be valueless or so complex and formidable that it could

not be put into effect. The forest should be broken up into logical units of management in each of which the situation is sufficiently simple to permit a reasonably accurate analysis and appraisal and the drawing up of specific provisions for management.

The working circle is the management plan unit; it is a major territorial division of a forest in which the conditions affecting the care and use of the timber crop are so interrelated that the area can and should be managed as a whole and under a single plan, and usually though not invariably under sustained yield.

SIZE AND BOUNDARIES

Working circles may vary in size from a few thousand acres to several hundred thousand acres. The area and the location of boundaries will be governed by many factors, among which may be mentioned: The objects and the intensity of management, the quantity and character of output desired, the topography, the lay-out of transportation systems, the sphere of influence of near-by industries or communities from an utilization or market standpoint, and, to a lesser extent, the composition of the stand as to types, age classes, and sometimes species.

Since most of these factors in a mountain country are strongly affected by topography, it frequently though not always happens that a working circle is a natural topographic area, such as the watershed of a river or large stream, or a group of such areas. There is some tendency in the national forests to include too extensive an area in a working circle. While no hard and fast rule can be cited, it is good practice to keep the area as small as the attainment of the objects of management and the exigencies of practicable logging will permit. The smaller the management-plan unit, the greater the chance for uniformity of conditions, the easier it is to appraise the situation correctly, and the more practicable it is to apply the prescriptions of management.

It is not necessary that a working circle consist of a consolidated territory within an unbroken boundary. It may be made up of several watersheds or blocks of forest land separated from each other by bodies of private land, land outside of national forest boundaries, or nontimbered lands, but in all such cases there should be something in common that establishes an interdependence between the scattered areas, as for instance, a common shipping or marketing point or a common transportation system.

Whether or not the boundaries are drawn to exclude bodies of land in other ownerships within the topographic area constituting the working circle will depend upon the relative area of such lands, upon the degree and stability of cooperation which is in effect or assured, upon whether or not the timber on these lands is to be taken into account in figuring the yield, and, for a national forest working circle, upon the policy of the Government as to acquiring title to them under the general exchange act or otherwise. As a general thing the presence of intermingled alienations in a working circle should not affect the location of its boundaries. The effort should be to have all owners join in carrying out a common plan.

The boundaries of working circles should, as far as possible, be well-defined topographic features. They need not coincide with

those of an administrative unit such as a ranger district, although the execution of the provisions of the plan may sometimes be simplified if this is the case. A working circle may be located in two or more forests, although this interposes obvious administrative difficulties and requires that one or the other forest staff be made responsible for general oversight over the progress of the plan and for keeping the necessary records.

It is desirable but not always practicable to establish the permanent boundaries at the start. We are now in the first stages of systematic management in the national forests, and our present understanding and knowledge of the many and complex factors involved is not always a sufficient basis for permanent delineation. It will undoubtedly be necessary to make many adjustments in boundaries as we get more information as to our resources and better crystallize our ideas on management. There will be a tendency to reduce the size of management units, both working circles and compartments, as management becomes more intensive, because of better transportation facilities, better markets, and closer utilization.

ORGANIZATION OF THE WORKING CIRCLE

For ease in visualizing and analyzing the problem, for clearness and definiteness in describing the forest growing stock, and for convenience in allocating operations and in keeping records of action taken, working circles are subdivided into blocks, compartments, and subcompartments. The division into compartments is best made on the ground at the time of the timber survey, so that all field data can be taken and assembled by compartments. Some compartments may be divided into subcompartments in the field at the same time. The process of setting out subcompartments, however, is a progressive one and will continue throughout the course of management. The formation of blocks can perhaps be decided upon better after the plan of management has been at least roughly shaped up.

THE BLOCK

The simplest procedure is to divide a working circle area directly into compartments and subcompartments. There crops up, however, in some cases the need for a unit intermediate in size, between a compartment and a working circle, a unit that will make possible a clearer statement of the policy to be followed in handling the resources in the woods and in keeping the records in the office. In Forest Service practice this unit is the block.

The block is a large division of a working circle, usually with topographic boundaries, consisting of a group of compartments or an undivided area distinguished from other areas by a marked difference in timber-sale policy, utilization or transportation possibilities, silvicultural treatment, or otherwise. If two or more noncontiguous areas make up a working circle, each of these areas needs a name for convenience of reference and would be called a block. A block might also consist of a large sale area, either existing or proposed, covering several compartments; or it might be a remote part of a working circle which is not to be utilized for many years and which is not in immediate need of subdivision; or it might consist

of several compartments which, under the timber-sale policy, are set aside as a reserve from which to supply an established sawmill plant after the completion of the current sale.

In very extensive plans based upon meager data and lacking a good topographic survey, all immediate needs may sometimes be satisfied by dividing the entire working circle into blocks without further division into compartments or smaller units.

The block is a division of convenience. It is not necessarily permanent and there need be no hard and fast rules to govern its use. For the sake of simplicity its use should be restricted to situations where a real need is to be served.

THE COMPARTMENT

The compartment is the forester's working unit of area. He plans and executes his operation by compartments or subdivisions thereof; he describes the forest stands, keeps an inventory, and records action taken, by compartments. The compartment is a permanent territorial division and its boundaries should be located with care and a full realization of the very practical purpose which it is to serve.

Needless to say, compartment boundaries should be plainly and permanently marked on the ground and clearly shown on all maps. The areas should be so designated that they may be readily identified on the ground and on the map. Wherever available, natural topographic features such as ridges, streams, cliffs, lake shores, etc., should be used to mark compartment boundaries. These may be supplemented by roads, trails, and property lines. A cove, a gulch, a hollow, or the watershed of a small stream makes a very logical, easily identified compartment.

In a level country or in a region where marked topographic features are lacking the rectangular system of the public land survey gives a very convenient basis for division into compartments. The section of 640 acres makes a compartment of convenient size and one that is easily found and identified on both the ground and the map.

Compartments need not be logging chances or sale areas, nor need they be uniform in the type, age-class, or condition of the stand. All such features are taken care of in the subcompartments.

A compartment may vary in size from less than a hundred acres to several thousand acres, depending upon the degree of refinement used in silvicultural treatment, and upon the size of the natural topographic units that characterize the terrain. If the compartments are too large, it becomes difficult to describe the forest land adequately, to allocate the various operations, and to record their history. If the areas are too small, there is introduced a needless and hampering complexity in management.

SUBCOMPARTMENTS

If the intensity of the management or the diversity of forest conditions call for it, the compartment may require division into smaller units. Subcompartments may be topographic divisions but are usually based upon the type, age class, or physical condition, or the prescribed treatment of the timber stands. For instance, a smaller

area covered by young growth or an old burn or a different forest type would be set out as a subcompartment. Again, the subdivision may be based on logging chances or timber sales.

A complete division into subcompartments does not have to be made at the time that management is initiated; from time to time there will be need to subdivide as sales are made, fires occur, and other conditions come about that change the character of a part of the stand in a compartment. The number of subcompartments will be in direct proportion to the intensity of management, to the length of time that a given area has been under systematic treatment, and to the complexity of the composition or character of the stand. Well chosen subcompartments show for themselves on the ground and usually need no artificial marking of their boundaries; the boundaries should, however, be shown on the map.

DESIGNATION OF UNITS

In the designation of blocks, compartments, and subcompartments on the ground, on maps, and in reports, it is good practice to give names to blocks and compartments, usually suggested by outstanding topographic features, and to number or letter subcompartments. However, in working circles in which the terrain is cut up into many small gulches and in which timber sales are of small size, subcompartments may sometimes be given names that identify them with the topography.

Where the public land survey is the basis of division, management units may be designated by townships, ranges, and sections.

COLLECTION OF DATA

The complete and intensive plans presented as models in the textbooks require a formidable array of accurate field data. Much of this information is of a kind that can be accumulated only after years of investigation and experience. In many of the national forests there is a decided shortage of such essential data as regional yield tables, tables of growth by species or types, and stock and stand tables for various types.

In many national forests the immediate need of the public for timber is too pressing to permit the shelving of applications until complete and satisfactory management-plan data are obtained. To meet this situation, which bids fair to continue for some time, some plan is needed at once even though complete and comprehensive data are lacking. It remains essential, nevertheless, that the principles of sustained yield, proper silviculture, and sound economics be safeguarded and that the course of exploitation in every working circle be directed along lines that will at least lead in the right direction.

It is entirely possible to construct plans that will not only serve all immediate needs, but will at the same time initiate systematic management, on the basis of a rather meager showing of fundamental data. A simple plan, the primary purpose of which is to provide for the cutting of the various stands of timber in the order indicated by their silvicultural needs and the dictates of good business judgment and in a manner that will assure satisfactory repro-

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duction—all without risk of a hiatus in the future production—can often be made upon information gathered in a rather extensive survey of the area involved.

The following is an outline of information needed as a basis for a simple plan:

1. PHYSIOGRAPHIC FEATURES

The topography, soil, and climate in the working circle have a direct bearing on the reproduction, growth, and utilization of the timber stand, and these natural factors should be analyzed in this relationship and all important features ascertained and recorded. Topographic features will, of course, be shown on the map.

2. FOREST STAND

The essential information needed is:

(*a*) The location, boundaries, area, composition, and condition of each of the commercial forest types in the working circle.

(*b*) The location, area, composition, and merchantable volume of stands of timber that are likely to be considered for cutting in the first cutting cycle.

(*c*) The proportion of the various age classes (in the case of partial cutting) in the timber stands by area, by volume, and by number of stems. This information may require the preparation of stock and stand tables for each type, though sometimes a good estimate based upon a few well-chosen sample plots will meet all immediate needs.

(*d*) A knowledge of the rate of growth to be expected per acre after the removal (in the case of partial cutting) of the mature timber according to the marking policy. For immediate practical purposes growth data based on systematically taken increment borings will serve until more accurate and complete figures are obtained from extended studies.

Data concerning the location, boundaries, area, composition, condition, and volume of timber stands should be so taken in the field that they may be recorded by compartments.

3. THE UTILIZATION SITUATION

In many cases, particularly in the national forests, the management of the timber resources for the next 10 years or longer will be governed by the possibilities of profitable utilization. It is essential, therefore, that the forester analyze this side of the general situation with considerable care. The judgment of a first-class logging engineer is of value in this analysis. A systematic study should cover such points as: Products to be disposed of, local and general markets, responsibility to local industries and communities, transportation facilities, methods of logging, labor supply, freight rates, effect of competing stumpage, possibility of correlated industries, etc. This information is used also in formulating the business policy to govern the disposition of the products of the working circle. Frequently, a brief statistical statement of the cut on the working circle during each of the last 10 years indicates the amount and steadiness of the present market demands.

4. OTHER INFORMATION

Any plan for the management of the timber resources that is not in entire coordination with the plans and policies for the various other uses of the land in that region is incomplete. The land-acquisition policy often has an important bearing on the handling of the timber in a given working circle. The use of the range for grazing is in many regions of great economic importance, and though it may sometimes conflict with the forester's plans for handling the timber, usually the two uses can be so coordinated as to make them both possible. In some regions the public has come to make very general and in some cases rather intensive use of forest areas, particularly the national forests, for recreation, including touring, camping, hunting, fishing, summer homes, etc. Such a use is a legitimate one and should be anticipated and taken into account in plans for timber management. The protection of city watersheds and of large catchment basins depended upon by irrigation districts for water supply is another use that must in many cases be fitted into the plan.

While management plans usually do not cover the field of protection in any detail, it is of paramount importance that in drawing up provisions for management, the protection of timber crops, both present and future, against insects, tree diseases, and fire should be kept constantly in the foreground in order that no opportunity for furthering the safety of the stands may be overlooked. Data should be gathered on the relationship of age classes, silvicultural systems, and logging methods, and on the liability of losses from insects, disease, fire, and storms.

5. MAPS

Of course, every forest manager wants a good topographic map of the territory in his charge, and as his work gets more intensive the need for an accurate map of this kind increases. At the start, however, large areas can be put under successful management without other than simple, inexpensive maps. A map showing ownership, drainage, outstanding topographic features, such as divides, transporation facilities, utilization plants, and towns and settlements, will usually serve as a satisfactory base on which to enter type lines and compartment and block boundaries and to show in bold relief the areas to be cut over during the period covered by the cutting budget. The scale of the map should be in proportion to the amount of detail to be shown; 1 inch to the mile will do for large working circles with very simple plans; 2 inches to the mile will better fit conditions in a smaller working circle or one in which there are more details to be shown; an intensive plan or a very complex situation may require a scale of 4 inches to the mile, or even larger. Often all of the data necessary can be shown on one map. Only in the more complex situations will separate type maps and ownership maps be necessary.

OBJECTS OF MANAGEMENT

A decision as to objectives is essential at an early stage in the preparation of the plan. After the information concerning the area to be put under management has been gathered and digested, the next step is to formulate and set down the purposes of management—

what the plan is designed to accomplish. When the aims of management are clearly understood, the making of a plan is greatly simplified.

The statement of purposes should include:

1. The chief products to be grown, such as saw logs, ties, mine timbers, pulp wood, or naval stores.

2. What markets are to be supplied—general, local, or both.

3. The part which the output of the working circle will play in local economics; the size and kinds of permanent industries that can be supplied; the communities that will be stabilized; and the need for securing new industrial undertakings to use the allowable cut and to enlarge the existing communities, or the necessity for a reduction in the local industries to a scale that will make it possible to supply them with timber permanently—in general, the responsibility of the management so to handle the timber resources as to give the greatest permanent local industrial benefits.

4. Whether conditions now permit the adoption of sustained yield or of only a continuous yield fluctuating in volume. In some unusual cases plans can now be made for nothing better than a periodic yield.

5. The changes in the proportion of age classes or in the composition of forest types which are desired and which are or may become practicable.

6. The indirect forest benefits to be maintained or bettered, such as watershed protection or recreational attractiveness.

7. The permanent transportation facilities which can be brought in or maintained by the wise handling of the timber resource.

SILVICULTURAL TREATMENT

The aim of silvicultural treatment in the national forests is to leave each cut-over acre in the best possible condition for the production of a succession of crops of timber, each crop approaching as near as professional skill can bring it to the full productive capacity of the site and type. The silvicultural treatment to be prescribed for each of the forest types will, of course, be chosen to fit in with and carry out the objectives of management. As a rule, satisfactory silvicultural methods have been worked out for each of the major commercial types in the national forests. For such types it is usually necessary only to decide which of the conventional methods will best fit the situation, but often the marking policy and instructions will need modification in order to meet the needs of the particular situation.

Management plans should not be made or construed so as to limit the continuous development and refinement of silvicultural practice. The forester often has serious limitations imposed upon him in his prescriptions for silvicultural treatment by the prevailing utilization practices based on local economics and therefore beyond his control. The situation may for the time being force a compromise between the desirable and the attainable. Such a situation, however, should not be accepted with complacency nor with the conviction that it will last forever. The last 20 years has witnessed remarkable advances in utilization; nearly every region has seen some or all of its "inferior" species come into active demand and its unmerchantable

sizes and qualities find a user. Even greater progress in this direction in the future is to be anticipated with confidence and the forester should be constantly on the alert to take advantage of every opening to bring about better silvicultural practice through higher standards of utilization.

REGULATION

In making a management plan it is in the section on regulation that the forester decides when and where and how much he is going to cut during the budget period ahead of him. It is obviously a very important part of the plan.

Nearly everywhere, both in virgin stands and in stands that have followed the unregulated cutting of pioneer days or are the result of old burns, the forest manager is faced with the necessity of converting as rapidly as may be through the use of the lumberman's ax, his very abnormal, often silviculturally stagnant, forest into an organized forest property that produces in accordance with the capacity of the site and has a more or less balanced representation of age classes. At the same time, he is seeking, in the national forests at least, to feed out the cut of his forest at a rate and in a manner that will approach as nearly as possible sustained yield, or at the least sustained operation.

Maximum production per acre and sustained yield are the forester's ideals, seldom reached in one man's lifetime, and never attained unless each man in the chain strives and plans to that end and hands the forest property over to his successor farther advanced than when he took it. To the extent that he can cut over each year a parcel of his working circle that represents the timbered area divided by the cutting cycle, just to that extent will he have an opportunity to put his forest into order and condition for maximum production and sustained yield.

Nevertheless, it is not always possible to figure out a sustained yield in the narrow sense of the term. The condition of the stand, as, for instance, in the case of a working circle where the growing stock is overwhelmingly overmature and decadent, may clearly indicate the necessity of cutting at a faster rate in the first cutting cycle than can be continued. Again, there are working circles where the great size of the necessary initial investment in transportation and utilization facilities demands a larger annual cut of timber over a period of years than can be maintained on a sustained-yield basis. The Forest Service is committed to sustained yield in the national forests as a policy and the principle is the beau ideal of every forester; every plan that is not cast on this basis must show convincingly that no stone was left unturned in the effort to solve the problem in favor of sustained yield and that the alternative adopted is the nearest approach to sustained yield possible under the circumstances. Abandonment of sustained yield because of silvicultural conditions is easier of defense than abandonment because of existing economic conditions, particularly in pioneer regions, for the problem may often be solved by the simple expedient of holding the working circle intact until the economic strictures are removed by a change in market requirements or industrial practices.

CALCULATION OF ALLOWABLE CUT

The literature of forestry is not lacking in the treatment of regulation, particularly the calculation of the yield. It is not intended here to go into the merits or demerits of the many and various methods that are in use or have been advocated by foresters here and abroad. Wide variations in forest conditions, utilization possibilities, and availability and character of growth data justify similar variations in the methods used in specific cases. In the management-plan work of the national forests in recent years there has been a marked tendency to get away from the use of formula methods of calculating the yield as a sole dependence. This is probably due to the fact that it has not often been possible to get together all of the information needed in sufficient detail and with sufficient accuracy to form a safe basis for such methods of calculation. Then, too, the silvicultural condition of the generally overmature virgin stands that characterize the national forests does not lend itself to methods of calculation developed mainly for stands that have been under management for many years.

If the forester is interested, as he usually is, in a course of management that will promise sustained operations without a hiatus in production and that will replace his poorly conditioned virgin stands with fast-growing, fully stocked second growth representing something approaching a normal forest, he will first find out over how long a period of time he must spread the cutting of his first crop of timber in order to allow the second crop to reach merchantable size and volume and take up the burden of supplying the needs of industry. Thus, except in forest types like Douglas fir on the Pacific coast that are cut clean and harvested only once in a rotation, the determination of the cutting cycle is an important step in the calculation of the allowable cut.

One rough-and-ready method of calculating the yield in selection forests, often used as a check on the results of more finished methods or used alone where the basic data for other methods are lacking, is as follows:

Assume an average diameter of merchantable trees and a volume per acre to represent a stand merchantable at the time of cutting.

Ascertain by increment borings or otherwise the number of years that it will take to bring the reserve stand left after removal of the first harvest up to the assumed size and volume. This is the first cutting cycle.

The total volume of merchantable timber in a type, minus the volume that is to be left for the second cut, divided by the number of years in the first cutting cycle, gives the annual yield for that cutting cycle and type. The sum of the allowable cuttings for the types is the total allowable cut for the working circle.

While the first cutting cycle is the only one used directly in the calculation of the yield for the first budget period, it is very desirable to carry the calculations through the second and remaining cutting cycles in the rotation. It is important because it applies a working test to the marking policy tentatively adopted and discloses any possibility of a hiatus or a change in yield in the future. Threatened lapses in yield may often be avoided or at least shortened

by an adjustment of the length of the first cutting cycle, or by a modification of the methods of cutting during the cycle, or both.

This method of calculating yield is crude indeed. It ignores a number of factors usually taken into account and should not be used if the necessary data for some more accurate method are available. The results, though conservative, are sufficiently accurate, however, to fill the needs of the simple plans that have been and are being made in many national forests, in which the chief concern is to set up a safe cutting program for the next 10 years and get systematic management under way and headed in the right direction.

For types that are cut clean, the cutting cycle coincides with the rotation age, and the determination of a rotation age is of great importance only for those types. Where partial cutting is used, the important factor is that there be left, in any present cutting, enough thrifty trees to produce a loggable cut of the desired products by the end of the cutting cycle. The present age of such trees or their age when they will be cut is relatively unimportant. If new even-aged stands are to be grown, however, sustained yield can only be secured by spreading the cutting of the present stands over the time required to grow a new forest to maturity on the area first cut over. As a general policy for the national forests, this rotation age will not be less than that at which the mean annual growth culminates, figuring the mean annual growth in terms of the chief product to be grown. Thus if Douglas fir saw logs is the desired product, and for the average site in a working circle the mean annual growth is greatest when the stands are 125 years old, the rotation will be at least 125 years, and plans must be made now to distribute the cutting of the existing stands over that number of years. If the working circle is reasonably uniform in site quality, a simple division of the productive loggable area by the number of years in the rotation is often the first step. Then multiplication by the average volume per acre for mature stands gives an approximation of the allowable annual cut. Refinements of the method should be used if justified by the available data.

TIMBER-SALE POLICY

When the annual possibility of the working circle has been ascertained and before decision is made as to when, where, and in what sequence the yield is to be harvested, it is in order to consider the policy that is to be followed in making timber sales; for only under unusual circumstances will it be practicable to order the utilization of timber stands solely in accordance with silvicultural needs. Accessibility, as it affects the cost of manufacture, quality in its effect on the value of the output, and policy as it relates to sound business practice as well as to public service, are and will be for many years to come, potent factors bearing on the allocation of the cut.

The statement of timber sale policy to be entered in the plan should be brief and to the point and should answer the following and similar questions:

1. What types of operations are to be sought: sawmill and logging, logging alone, combination of all commodities, separate operations for each commodity, etc.?

2. What logging methods and transportation systems are to be required, encouraged, or forbidden? Is there need for a progressive

development of the transportation system and how does this affect the order of cutting or the sale policy?

3. Are large or small sales or both to be sought? Long-term or short-term contracts? What number of operations is desired?

4. What should be the policy as to the use of small material, inferior species, and by-products? How far should the management go in forcing better utilization? Should concessions or adjustments in price for the better species be made for this purpose?

5. What attitude is to be taken toward the development of new business, new markets, and local industries?

6. What measures are necessary to maintain or develop competition between purchasers? What particular recognition should be given established operators?

7. To what extent should recreational and scenic considerations be taken into account in making sales?

8. What is the policy regarding sales at cost and free use of timber? Is a reserve for local use necessary?

THE ALLOCATION OF THE CUT AND CUTTING BUDGET

The cutting budget is the decision that follows the appraisal of the situation and the statement of objectives and policies. It is the summation of the plan and is a direct call for action. As written in the report, the cutting budget is a list of compartments, subcompartments, or chances to be cut under the provisions of the management plan during a certain period of years, in national forest practice usually 5 or 10 years. The areas to be cut are listed in the order of cutting decided upon after full consideration of the silvicultural condition of the various stands or tracts of timber on the one hand, and of utilization and policy considerations on the other.

In the management plans now being made in the national forests an attempt to list the areas to be cut each year during the budget period is seldom made, nor is it usual to provide for a certain volume of cut for each year in the period. It is the common practice to lump the cut, allocated to specific areas, for the budget period, with the understanding that the cut will be fed as uniformly as possible year by year. It is seldom that market and other conditions remain so fixed that the forester can dispose of his timber in an even flow year after year during any extended period.

THE BUDGET PERIOD

A definite commitment to a program of cutting involving both the time and the place of operations should be made for only as many years ahead as the forester can, with reasonable confidence, foresee the situation. It is better to lay out a five-year program based upon careful diagnosis of a known set of circumstances than to draw up a more pretentious budget covering a much longer period where the wish is father to the thought and a vivid imagination is the main dependence. The length of the budget period may be greater, obviously, in areas where the timber is sold in fairly large bodies and under long-term contracts than where the reverse is true. In the western national forests the cutting program is usually made for a 10-year period; in the eastern district 5 years is the usual budget period.

THE AREAS TO BE LISTED

There are many points to be taken into account in choosing the areas to be cut and in listing them for cutting. So far as it is practicable the silvicultural condition of a stand should be the governing factor in a decision as to its place in the cutting budget; the areas that are most overmature and decadent as a rule should be cut over first. Timber stands that are in good condition and are growing in quantity, quality, and price should be placed in future budget periods. Then, too, the forester should not lose sight of that ideal, the normal forest, and arranging the order and location of his operations should have constantly in mind an approach to normality in the next rotation.

But, as stated before, it is seldom that silvicultural conditions are the sole or dominating influences in the allocation of the cut. It is frequently necessary to build expensive and extensive transportation systems in a working circle. The progressive extension of such a system has to be taken into account and sales laid out accordingly. The future wants of existing operations have to be planned for and prospective sales listed with an eye to fitting those needs. Business strategy will often suggest an allocation and order of cutting designed to stimulate competition, to find a bidder for an undesirable tract, to force the clean-up of some relatively undesirable area, or to attract an operation of a certain desired type and character. In the national forests the harvesting of timber depends upon its sale to private enterprise and timber can not be sold unless some one wants it. Merchantability is an essential requirement for each area listed in the budget.

The chief purpose of a cutting budget, to bring about a systematic harvesting of the predetermined yield for the period involved, may be defeated, or at least impaired, if it is entirely inflexible. After all it is only a means to an end and is by no means sacred. All plans should provide that the managing forester keep the program under constant scrutiny and that he initiate steps to remedy or improve it as soon as a change in circumstances or the acquisition of new knowledge warrants a change. In order to give the man on the ground more leeway for good silviculture and the exercise of business judgment, it is frequent practice to put into the budget a number of alternative areas or to leave a certain part of the indicated cut unallocated by area.

With all the information and skill available it can not be expected that cutting budgets can be made, even for short periods, to anticipate every contingency that may arise—it is essential that ample provision be made to keep the program in harmony with circumstances. If the management plan is to come to anything it is essential that it be practicable; the budget is the direct contact between the idea and the action, and if it can not be put into effect on the ground the whole plan fails and the time, money, and thought put into its preparation are lost.

THE MANAGEMENT-PLAN REPORT

The way in which a plan is presented has much to do with its effectiveness and value as a tool of management. The purpose it is

designed to serve is comparatively simple, but the subject covered is broad and frequently complex. Considerable effort may therefore be required to present the plan in such a simple and direct way that those who are to translate the plan into action can get from it the essential things to be done without difficulty and without confusion.

THE THREE PARTS OF THE MANAGEMENT-PLAN REPORT

A management-plan report may be presented under three main chapters:

(1) The foundation, in which is contained a brief, well-balanced description of the governing conditions as they exist according to the best information available. Brevity should be attained by sticking closely to facts and conclusions concerning the essential elements only of the situation. This chapter is in effect the statement of the problem.

(2) The plan—a concise, direct statement of the objectives of management, the controlling policies, and the action to be taken. This chapter represents the solution of the problem.

(3) *The appendix.*—A systematic file of all of the information in the form of statistics, maps, etc., that has been taken into consideration in making the plan. In it also are placed discussion of alternative but rejected measures and calculations, detailed marking rules, silvicultural directions, and all other existing information to which the forester may need to turn to get a better understanding of the plan, to carry out the prescriptions of the plan, or to revise the plan. The appendix should be cumulative.

REPORT OUTLINE

In order that management-plan work might grow naturally and along lines dictated by conditions on the ground that there has been no effort made in the Forest Service to prescribe a uniform or official outline. A number of outlines have grown into common acceptance and use in the several national forest districts; the one given here as an illustration is fairly typical. It was developed in the southwestern district to fit the conditions prevailing there.

(1) FOUNDATION

Introduction.
Physiographic features.
    Topography.
    Soil.
    Climate.
Forest description.
    Types and silvical features.
    Situation as to fire.
    Summarized tables of area, volume, and status.
    Discussion of growth and yield.
Economic situation.
    Towns and communities—their relation to the forest.
    Wood-using industries.
    Markets.
    Transportation.
    Nonwood-using industries.
    The ownership situation.

(2) MANAGEMENT PLAN

Objects of management.
Silviculture.
    Methods of cutting.
    Methods of brush disposal.
    Methods of logging.
    Silvicultural studies.
Regulation.
    Rotation and cutting cycle.
    Calculation of allowable cut.
    Regulation policy.
    Sales policy.
    Cutting budget.
Administrative correlation.
    Exchanges, grazing, roads, recreational use, etc.

(3) APPENDIX

Detailed estimates and descriptions by compartments or other units.
Stock and stand tables.
Growth data.
Regulation calculations and discussion.
Detailed silvicultural directions by types.
List of existing utilization plants and capacity of each.
Maps.
Miscellaneous.

It has become customary in the Forest Service to submit a very brief summary of the plan proper as page 1 of the report. This summary presents at least the following information:

Name of working circle.
Location.
Area—timbered and nontimbered.
Stand—composition and merchantable volume.
Rotation and cutting cycles.
Silvicultural system to be used, by types.
Yield—average annual cut and total cut for a specified period, by volume and by acres.
Predicted periodic or annual cut in second cutting cycle.

In writing management-plan reports it should be kept constantly in mind that the objective is to give the man on the ground a clear understanding of what is to be done with the timber resources. The plan proper should contain only definite conclusions and is no place for recording observations, conjectures, arguments, or discussions. Such matters, if there be any, properly belong in the appendix.

THE CONTROL AND APPLICATION OF MANAGEMENT PLANS

To put a plan of management into effect in a working circle requires, (1) that the plan be pracicable, and (2) that the local force have executive ability. Almost never will a plan be found that can be put into action and carried out without special and sustained effort on the part of the managing forester and his staff. The plan supplies to these men the necessary guidance in much the same way that the architect's plans and specifications guide the craftsmen whose skill and energy must be depended upon to bring the structure to completion.

CONTROL RECORDS

Systematic management can not long continue with any degree of success without some form of bookkeeping. Even the very simple management prescriptions that are in many of the plans for the national forests require that cumulative records be kept of operations in the woods. So far no entirely satisfactory set of control records has been devised and put into operation in the Forest Service, and this remains to be done, perhaps only as the result of experience, as the next step in systematizing management work.

Experience here and abroad has demonstrated that the best results in the way of keeping a record are obtained where simplicity is an outstanding feature of the system used. It would seem that reduced to this plane, the essentials are: (1) A progress map on which is entered with appropriate symbols the location, area, date, and character of each utilization or silvicultural operation; (2) a control sheet for the working circle by budget periods on which is entered a record for each unit of the time it was cut, the transaction under which it was cut, the amounts cut, the method of marking used, and the condition of the area after cutting. This may be placed on the same sheet as the cutting budget, or on a separate sheet facing the budget to make easy a comparison of the action planned with the accomplishment.

The above represents the bare essentials of a record for a simple plan, it will not, of course, serve the purposes of a cut-over land record, nor will it supplant detailed inventory or stock records. Its purpose is simply to record the progress of the work of carrying out the cutting budget.

KEEPING THE PLAN ALIVE

To the end that the management may be a progressive, growing thing, responsive to changes in circumstances and taking full advantage of every favorable opportunity, it is essential that steps be taken in a systematic way as rapidly as possible to remedy the lack of information that in the first place forced the making of an admittedly crude plan. As fast as greater knowledge is acquired or changes in controlling circumstances occur the plan of management should be amended, modified, or revised, if such action is called for. Periodic revision will undoubtedly be necessary in all plans. In many plans the need and the opportunity for improvement and growth will more nearly be continuous than periodic. To those to whom this thought may be disconcerting, because of their conception of a management plan as a fixed line of action to be followed through to the end, it may be recalled that forest management in this country is in its pioneer stage, that the transition from timber mining to organized forest harvesting is just beginning, and that any plan made now will be outgrown and discarded as a misfit in a few years unless it is kept plastic, flexible, and in complete adjustment with the ruling conditions.

APPENDIX

The plans that follow will, in addition to presenting certain management situations common to the national forests, show what data were assembled, how those data were used, and what solutions were arrived at in those particular situations. While all of these plans have received official approval and are in effect, they should not be regarded as models in either sense of the word. It goes without saying that the conditions that affect and control management are too varied and too complex and are found in too great a variety of combinations to make it likely that any of the plans given here would fit other specific situations to any satisfactory degree. And these plans are not perfect. They are merely samples of the work of the Forest Service in this field.

The plans have been edited only slightly, and that mainly through the deletion of statistical material from the appendices to save space. It has not been practicable to reproduce the original maps which accompanied the plans; there have been substituted small-scale maps showing the location and the boundaries of the working circles and some of the more salient features of topography and culture.

Though the plans are in effect, that for the Rio Pueblo working circle on the Carson National Forest is not being carried out in full because of an unexpected and probably temporary loss of market. Conditions there illustrate the importance of the marketing and transportation factors in managing forest properties. The Rio Pueblo plan has been included partly to picture the situation which confronts many national forest officers when they attempt to organize for sustained yield production forests which are difficult of access, from which only certain products can be sold, or which are dependent on unstable markets.

MANAGEMENT PLAN FOR CUSTER WORKING CIRCLE, HARNEY NATIONAL FOREST, S. DAK.

Respectfully submitted.

C. B. Webster, *Forest Assistant.*

Approved January 7, 1924.

J. F. Conner, *Forest Supervisor.*

Approved March 31, 1924.

A. S. Peck, *District Forester.*

Approved January 8, 1925.

L. F. Kneipp, *Acting Forester.*

SUMMARY

LOCATION

Harney National Forest. Principally in Custer County. A small area in Pennington County. All in South Dakota.

AREA (ACRES)

Timbered, 167,652;[1] nontimbered, 26,729; total, 194,381.

STAND

Volume of stand in trees 10 inches and over, d. b. h., 468,969,000 feet b. m. Composition, 100 per cent western yellow pine.

ROTATION

One hundred and forty years, divided into four cutting cycles of 35 years each.

PER CENT OF MERCHANTABLE STAND TO BE REMOVED IN FIRST CUTTING CYCLE

Seventy per cent by volume (approximate).

YIELD

Average annual cut, 7,000,000 feet b. m.; total cut, 1921–1930, inclusive, 70,000,000 feet b. m. The indicated acreage that can be cut over annually is 3,138 acres.

PREDICTED CUT IN SECOND CUTTING CYCLE

Twelve million three hundred and forty-six thousand feet board measure per year.

INTRODUCTION

The Custer working circle of the Harney National Forest is established to provide a sustained yield of timber for a permanent woods industry. This industry will insure a steady income for the towns within the circle. Directly or indirectly, a large portion of the population of Custer and adjoining terfitory is dependent upon the timber business for a livelihood.

Custer, the largest and most important town within the circle, has some 600 inhabitants. Originally the mining industry provided the principal source of income. To-day, however, only a very small amount of prospecting and assessment work is being carried on. No mines are running. There is very little promise of any considerable development in the near future. Next to logging and lumbering, ranching is the most important industry. There are no manufactories in Custer. It serves mainly as a supply center for the lumbermen and ranchers within the circle.

Pringle, the only other town in the circle, has less than 100 inhabitants and is of secondary importance. It serves as a supply point for the southern sawmills and ranchers and is a shipping point for cattle and lumber. Pringle is about 12 miles south of Custer on the Denver-Deadwood Highway and the Chicago, Burlington & Quincy Railroad. A sustained yield of timber will unquestionably benefit the town.

Assurance of a sustained yield within this circle will undoubtedly bring about the erection of a finishing or woodworking plant at Custer that will be able to handle all of the yearly cut of lumber. Such a plant will mean that the small operator need not depend upon the Chicago, Burlington & Quincy Railroad for a market, except for ties. Both large and small operators can sell direct to such a plant. There will be little tendency to ship their products out of the Black Hills. Better and closer utilization will result. Economic conditions in the circle will improve accordingly. The inhabitants are bound to be more prosperous.

The fact that most of the ranchers spend much of their time working at some other occupation clearly indicates that ranching is not a paying proposition on the whole, although it will undoubtedly always be carried on to some extent. Lumbering furnishes yearlong occupation, and an increasing number of persons desire to engage in it. A sustained yield of timber is therefore a very necessary adjunct to the economic life of the circle, and vitally important to the town of Custer.

[1] Includes 394 acres classified as inaccessible.

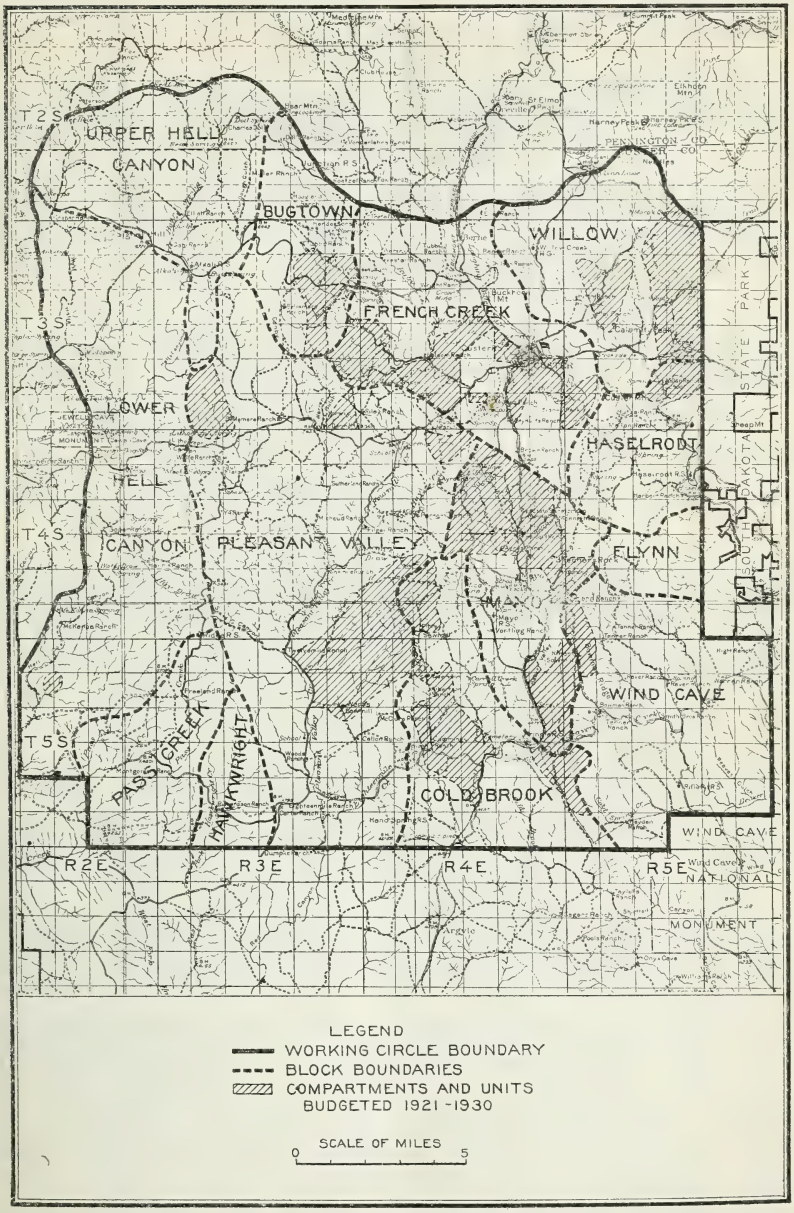

FIG. 1.—Custer working circle, Harney National Forest, S. Dak. Full division into compartments and units is not shown

OWNERSHIP OF TIMBER

With the exception of a small amount of timber on homestead patents, and some on mining patents, the entire volume is owned by the United States. The patented timber is so scattered that it will not influence the management of the national forest timber.

PREVIOUS CUTTING

Most of the timber cut within the Harney forest in past years has come from the Custer circle. The earliest cutting, done when Custer was first settled after the discovery of gold in 1874, was in the immediate vicinity of the town. Since that day cutting has been almost continuous, although the cut was small between about 1890 and 1920. The earlier operators removed only the very best of the timber and it has been possible to make second and even third cuts on the same areas. Some of the stands are still good producing forests.

PURPOSES OF THIS PLAN

The purposes of this plan are:

1. To bring together all available forest data necessary to construct and make workable a program that will insure a sustained yield of timber for the circle.
2. To determine what area and volume can be cut, and the time and place of cutting, to put the area on a sustained yield basis, insure the best use of the forest, and best serve the interests of the Government.

DESCRIPTION OF THE WORKING CIRCLE

TOPOGRAPHIC FEATURES

Location.—The Custer working circle includes those areas within the Harney National Forest drained by French Creek, Hell Canyon, Pass Creek, Hawkwright Creek, Pleasant Valley Creek, Carrol Creek, Cold Brook Creek, Willow Creek, Flynn Creek, and Beaver Creek. The circle boundaries are defined by topographic features and surveyed forest boundary lines. All or parts of the following townships are included:

T. 2 S., R. 2, 3, 4, 5 E., B. H. M.
T. 3 S., R. 2, 3, 4, 5 E., B. H. M.
T. 4 S., R. 2, 3, 4, 5 E., B. H. M.
T. 5 S., R. 2, 3, 4, 5 E., B. H. M.

The map accompanying this plan shows the location of the circle more definitely.

Acreage.—The total area of national forest land within the circle is 194,381 acres. Of this area, 167,258 acres are classified as accessible forest-producing land; 394 acres are classified as forest-producing land inaccessible for logging; and 26,729 acres are nontimbered.

Topography.—Six of the 10 creeks listed under "Location" flow to the south, joining other streams outside the forest boundary. Willow Creek flows south, but into French Creek which, together with Flynn and Beaver Creeks, flows east and southeast. The circle is, therefore, in general a slope to the south and east.

East of Pleasant Valley the country is characterized by high ridges with steep slopes, and narrow relatively flat valleys in between. From Pleansant Valley west, the limestone formation gives a country with relatively broad, flat-topped ridges, and narrow canyons with steep sides and usually with some rimrock. This is referred to locally as the "limestone." In all of the circle many side draws branch from each main draw. Pleasant Valley is a wide flat valley, but the side draws are of the canyon type common to the limestone region. The country in the immediate vicinity of Custer is rolling, with rock outcrop on the highest points.

The elevation ranges from slightly over 4,000 feet on the south side of the circle to over 6,000 feet in several places on the north side. The elevation at Custer is slightly over 5,300 feet. Pringle is about 4,800 feet.

The soil is rather shallow as a rule, except in the stream bottoms. On the slopes it frequently contains a large amount of surface and slide rock. There is more or less rock outcrop to be found on every ridge. The soil-moisture content varies from dry to fresh on the ridges and fresh to moist in the stream bottoms.

STAND

Small areas of white spruce (*Picea glauca albertiana*) and aspen are found in the central and northern parts of the circle. These species are not in sufficient abundance, however, to be of commercial value. The principal species is western yellow pine (*Pinus ponderosa*), which grows in pure stands over the entire circle.

The total area of forest-producing land within the circle, exclusive of the small amount of timbered private land, is classified as follows:[2]

Total forest-producing land, 167,258 acres; reproduction, 29,412 acres; poles, 28,008 acres; merchantable, 109,838 acres; inaccessible, 394 acres.

The average stand per acre on the area covered by merchantable timber is 4,270 feet b. m. The best of the timber is found in the central and northern part of the circle. Much of the stand in the southern part is of the scrubby foothill type. The total volume of accessible merchantable timber within the circle is estimated at 468,969,000 feet b. m.

Character of stand.—Three general age classes are found in the yellow-pine stands in this circle. These classes, with the type symbols generally used to designate them on the management-plan maps, follow:

Class	Symbol
1. Reproduction (under 6 inches d. b. h.)	1–20
2. Poles (6 inches and up to small thrifty "blackjack" trees)	20–80
3. Merchantable timber (10 inches and up)	80+
a. Mature and decadent, removed first cut.	
b. Thrifty to mature, removed second cut.	

There is very little, if any, mature timber over large areas of the Upper Hell Canyon and Bugtown blocks at the present time (1923) because of the depredations of the Black Hills beetle (*Dendroctonus ponderosa* Hopk.) between 1898 and 1910. Small patches of beetle-killed trees are found scattered throughout the circle. Good stands of reproduction have come in, however, in almost every area where the mature timber has been destroyed by this insect. There is little active infestation at the present time.

The best timber within the circle is found in the north central part of the Pleasant Valley block. Timber in the vicinity of Custer is good average pine for the Black Hills. The foot hills timber in the southern part of the circle is short boled, with a rapid taper. It grows more slowly than the average.

The mature and decadent timber, class 3a, is as a rule very defective. This is primarily due to rot entering through old fire scars at the base of the tree or through rotten limbs on the bole. Deductions in scaling timber cut in sales often amount to 25 per cent. After the first cutting cycle is completed, it is estimated that the deductions will be reduced to not over 10 per cent. This will have a marked effect on the volume obtained per acre.

Natural reproduction is very good over the entire circle. It is best, however, in the central and northern parts where growth conditions are most favorable. On many areas the reproduction is so dense that stagnation occurs after 15 or 20 years. Heavy, wet snows cause a large loss through deformity (snow bend) on such areas and have the same effect as a heavy but unskilled thinning. Except on the very worst burns, reproduction is almost certain to show up in three to five years after the fire. Even very bad burns, such as the one at Mayo, reseed as a rule in 10 or 15 years.

Cut-over stands vary considerably in silvicultural condition and volume, depending on the original stand. As a general rule, about 70 per cent of the original merchantable volume is removed. The following figures for timber

[2] These figures do not clearly indicate the true character of the stand, since the types are classified according to the predominating age class found on the area when cruised. Reproduction is found in varying quantities over the entire forest-producing area (with very few exceptions). Numbers of trees of the pole class are ordinarily found under the stands of mature timber. Such conditions are characteristic of the yellow-pine stands throughout the Black Hills.

10 inches d. b. h. and larger show the results on average acres, as determined by two different studies:

Studies by	Year	Average original stand [1]	Amount cut	Per cent	Amount left	Per cent
		Ft. b. m.				
Greeley and Granger	1915	5,600	4,164	74.5	1,436	25.5
Johnson and Tinker	1922	5,623	3,936	70.0	1,687	30.0

[1] Both these studies were made on areas where the average acre carries a larger volume than the average for the Custer circle. The areas carry, also, more than the average number of intermediates. In each case, however, an effort was made to pick areas that would give an average acre for the Black Hills region.

The growth in the virgin stands is practically nothing, decay in most cases being equal to and frequently greater than increment. The increment in cut-over stands amounts to 254 per cent in 35 years, according to predictions made on the basis of growth studies by Forest Examiner F. R. Johnson. (See Tables 2 and 4.) This is predicted on the assumption that growth continues at the same rate during the last 15 years of the cutting cycle as it does during the second 10-year period.

ECONOMIC SITUATION

ACCESSIBILITY

The Black Hills branch of the Chicago, Burlington & Quincy Railroad passes through the circle from south to north. Fair to good roads radiate in all directions from Custer and Pringle. Secondary and woods roads make almost every unit east of Pleasant Valley easily accessible. West of Pleasant Valley there are fewer roads, and on the average they are in poorer condition. Logging-road construction in the main draws is not difficult, as a rule. Feeder roads in the side draws usually involve heavier construction, with consdierable rock work, especially west of Pleasant Valley.

PRESENT AND FUTURE MARKETS

The towns of Custer and Pringle and the numerous ranches scattered throughout the circle offer a local market for a limited quantity of the lumber produced. The Burlington Railroad is now (1923) the largest individual purchaser of the timber products of the circle. This company buys railroad ties, coal and grain doors, and some bridge and structural timbers. The Warren-Lamb Lumber Co., of Rapid City, buys logs, mill-run lumber, and slab wood. In addition there is a more or less uncertain market for mine ties, mine timbers, fence posts, lath, and shingles. Fuel wood is always in some demand. The market for lath and shingles can be developed into a very good business if properly handled.

The sustained annual yield as fixed in this plan is more than sufficient to care for all present local demands. Should mining again become an active business there will be a marked increase in the local demand for all kinds of lumber and timbers. The allowable cut would still be more than sufficient for local needs, however. The surplus will in the future be used to meet the increasing demand from the prairie regions surrounding the Black Hills.

The future will also bring an increasing demand for box lumber. This will be supplied from any surplus remaining after the above-mentioned demands have been cared for. The surplus will undoubtedly be too small to supply the railroad demand. This will force the Burlington to turn to the lodgepole forests in the Big Horns for the products it needs, especially ties. Such a move will be very desirable from a Forest Service standpoint.

POPULATION AND LABOR SUPPLY

East of Pleasant Valley the circle is well populated, principally by small ranchers and stock growers. Stock raising is the principal occupation in the west part. Land suitable for farming is not so abundant there, and ranches are consequently fewer and more widely separated.

Woods and mill labor is generally obtained locally in sufficient quantities to supply the demand under the present methods and location of lumbering. However, imported labor will undoubtedly be necessary in the case of large operations in the western part of the circle.

COMMUNITY AND LOCAL NEEDS

At present the largest single local need is fuel wood. The per capita wealth of the circle is rather low at the present time. When this situation changes for the better there will be a need for building lumber of all kinds.

Fuel wood is obtained under free-use permit or commercial sale. Building material is obtained under regulation S–22, or by purchase from commercial operators.

TRANSPORTATION

The Chicago, Burlington & Quincy Railroad, Black Hills branch, offers the only shipping facilities to markets outside the Black Hills, except that operators in the extreme western part of the circle may find it cheaper to transport their products by truck to the Burlington main line, which roughly parallels the west side of the Harney forest between Edgemont, S. Dak., and Newcastle, Wyo. Ties and lumber are transported from mill to siding by motor or animal haul.

MILLS

At present (1923) there are 15 small sawmills operating more or less steadily within the circle, cutting principally national forest timber. One or two other mills cut intermittently in private timber and will eventually make application for national forest timber. All of these mills are in the portable class, with capacity varying from 5,000 to 25,000 board feet per day, log scale. All but one of these mills are located within a radius of less than 10 miles of Custer or Pringle. Many of them are within a 5-mile radius of these towns.

All of these mills can be permanently supplied with logs if they do not increase their present rate of cutting. They must, however, go further from the shipping centers for their source of supply in the future, until such time as the entire circle has been cut over for the first time.

There is an urgent need in the circle for a woodworking industry that can utilize the odd lengths, tops, and cull logs that are now largely wasted. A good box factory at Custer, built to utilize such materials, should be a paying proposition and will no doubt be erected at some future date.

SILVICULTURAL POLICY

1. Every effort will be made to place the forest-producing area in the best possible silvicultural condition.
2. Marking will be done according to the revised Black Hills marking rules. (In the original, reference was made here to the Appendix, from which the marking rules are omitted in this publication.)
3. All trees infested with the Black Hills beetle or similar insects will be marked for cutting, regardless of age or class, and wherever such trees are found an effort will be made to dispose of them immediately.
4. Young stands which need thinning will be given that treatment wherever market and other conditions make it possible. Forest officers making such thinnings must be thoroughly competent and must have written authorizations from the forest supervisor.

MANAGEMENT POLICY

OBJECTIVES

1. (*a*) To maintain a sustained yield of forest products for the use of the local people and, where a surplus is produced, for the general market.

(*b*) To furnish steady employment for the local people in woods work and in the manufacture of forest products.

(*c*) To maintain a permanent industry which will offer a market for timber as it becomes ripe for cutting.

2. (*a*) To cut over the forested area four times in the next 140 years, beginning from the year 1921, removing the mature, decadent, and defective timber in the first cut.

(*b*) To make such thinnings in young stands as are economically possible.

REGULATION OF THE CUT

1. *Rotation.*—A rotation of 140 years has been chosen as the basis for management. This period is based largely on figures of growth obtained by Johnson in cut-over stands in the Black Hills National Forest in 1922. Johnson's figures indicate a rotation of approximately 130 years. Pending confirmation of his calculations by continued studies during the next seven years, a rotation of 140 years has been adopted as conservative. (See p. 37 for growth figures obtained by Johnson.)

2. *Cutting cycles.*—The best growth figures available indicate that four cutting cycles of 35 years each during the rotation are feasible. In any case the 35-year cutting cycle for the removal of the first cut appears to be satisfactory, inasmuch as it provides for the removal of the decadent and defective timber as quickly as possible. Likewise it produces a yield sufficient to maintain established industries on a sustained yield basis, and furthermore, does not endanger continuation of a sustained yield through the subsequent cutting cycles. (See p. 30 for detailed calculations.)

3. *Allowable cut.*—Calculations to be found in the Appendix show that an annual cut of 7,000,000 feet board measure is possible. This volume limitation is therefore adopted to apply during the remainder of the period 1921–1930. It is not adopted for the entire cutting cycle for the following reasons:

(1) The accuracy of some of the timber estimates used in these calculations is doubtful.

(2) Within the next seven years a large part of the circle west of Pleasant Valley, which at present is not covered by accurate timber surveys or estimates, will have been mapped and cruised. The accurate data such a cruise will give may indicate that some changes must be made in the size of the annual allowable cut.

GENERAL PROGRESS OF THE CUT

The units listed in the cutting budget are those most in need of cutting, as determined by their maturity or by the presence of injurious insects. Qualifying factors considered in making the selections are:

1. Volume of timber available; practicability of mill settings.
2. Location, with reference to as equitable a distribution of timber-sale work among ranger districts as is possible.
3. Location with reference to present mills.
4. Accessibility.
5. Presence or absence of valid mining claims in unit.

Most of the cut for the first 10-year period will come from French Creek, Pleasant Valley, Willow, Mayo, and Cold Brook blocks in the order named.

TIMBER-SALE POLICY

1. The number and size of sales will be governed by the control budget and the foregoing policies.
2. Sales will be made with the idea of caring for established operators first and giving them a continuous cut. Thus bodies of timber near or adjoining going operations will be advertised only when the going sale is about completed.
3. The average annual cut for the period 1921–1930, inclusive, will not exceed the maximum of 7,000,000 feet board measure.
4. Until competition and demand become keener timber will be advertised only on application.
5. Units will be appraised on the basis of a mill of capacity sufficient to handle most efficiently the volume of timber being sold.
6. Sales to operators desiring to cut over 1,000,000 feet annually will be confined to Pleasant Valley, Lower Hell Canyon, Pass Creek, Hawkwright, and Wind Cave blocks, unless due consideration shows that an operation of such size in another block would best serve the interests of good forest management.
7. Sales made under regulation S–22 will be confined to small isolated tracts of timber that are not a logical part of a large unit, except that in cases where

this may prove impracticable definite S–22 areas will be established, the location to be approved by the forest supervisor before any sales are made.

8. In sales too small to warrant the travel and time for scaling, volume will be obtained, at the discretion of the forest supervisor, by tree measurement.

9. Sales of isolated patches of timber not listed in the control budget are permitted. Such sales must be approved by the forest supervisor.

10. An unallotted area will be left in the cutting budget to permit such sales as are mentioned in paragraphs 6, 7, and 9. When such sales are made the unallotted area in the budget should be reduced accordingly. Units coming under paragraph 6 will be listed in the budget as soon as timber-survey data are available—probably 1924.

11. All brush and débris resulting from timber-sale operations will be disposed of according to instructions in the District 2 Forest Management Handbook. This means disposal by piling and burning in most cases.

12. Any form of logging other than by animals or motor-propelled vehicles will be permitted only by special authorization of the district forester.

13. In case the logging operator does not remove cordwood or other by-products from the sale area, every effort will be made to sell such products to other operators.

14. If valid mining claims are known to exist in a logical sale unit and are so located that they will interfere with the logging or will necessitate the leaving of one or more tracts of timber isolated, the unit will not be budgeted until near the end of the cutting cycle. Before then the claims may be either abandoned or patented. Exceptions to this general policy may be made by the forest supervisor.

CUTTING BUDGET FOR 1921–1930

The cutting budget is given on separate sheets. For each unit a specific year has been designated as the time when cutting may be expected to begin. It is not intended that this should be a mandatory date, but rather that it should be a guide to the approximate time when the unit will be advertised for sale. It might become more desirable to sell in 1925 a unit that is listed for sale in 1928. When due consideration shows that such a change will bring greater benefit to the forest and to the United States, the change should be made. Authorization for such a change will not be necessary from anyone approving this plan except the forest supervisor.

Not all of the possible allotment is being budgeted by separate units. The unallotted balance will be used to care for unforeseen small sales and sales in areas not at present covered by intensive timber surveys.

Cutting budget, Custer working circle, Harney National Forest, period 1921 to 1930

Location			Plan				Record					Methods, remarks, and references
				Stand to be cut					Amount cut			
Block	Compartment	Unit	Government area	M feet b. m.	Year to start cut	Method, treatment, etc.	Time cut (year completed)	Sale	M feet b. m.	Cords	Cull logs, linear feet	
French Creek	V	Sec. 24, T. 3 S., R. 4 E., B. H. M.	6	20	1921	Regular. (See Marking Rules.)	1922	Mark Sheehan, Feb. 5, 1921.	20.06			
Do	V	Granite Reef	356	500	1921	do	1922	M. O. Connor, Mar. 10, 1921.	463.00			Excellent stand left over most of area.
Do	V	Custer R. S	50	50	1921	do	1922	Paul Rosse, Mar. 24, 1921.	53.10			
Mayo	I	Norberg	55	123	1921	do	1922	Frank Nihart, July 29, 1921.	245.2			Good stand left.
French Creek	V	Custer R. S	100	100	1921	do	1923	Paul Rosse, Aug. 13, 1921.	159.9	55		
Cold Brook	III	Pearson	40	63	1921	do	1922	A. M. Boggs, Oct. 11, 1921.	65.2			Old stand; heavy cut, cut over once previous; good reproduction on area when cut.
French Creek	V	116	10	22	1921	do	1922	J. H. Mayberry, Nov. 21, 1921.	22.9			
Haselrodt	I	Walsh	60	200	1922	do		J. H. Bostwick, Dec. 13, 1921.				
Willow	IV	Kneeland ranch	160	250	1922	do		F. V. Carrol, Dec. 13, 1921.				
Mayo	IV	West Beaver Creek	140	200	1922	Regular. (Scattered patches in burned-over unit.)		A. L. Duncan, Dec. 13, 1921.				
Cold Brook	III	Pearson	10	32	1922	Regular	1922	A. M. Boggs, Feb. 15, 1922.	32.2			Old stand; heavy cut much defect.
Mayo	IV	Sanatorium	40	135	1922	do	1922	J. H. Mendenhall, Feb. 18, 1922.	143.1			Good stand left.
French Creek	V	Part of 114	56	500	1922	do	1923	Fred Higgs, Mar. 27, 1922.	86.6		308	
Lower Hell Canyon.	II	Lithograph	30	50	1922	do	1923	M. J. Bailey, Mar. 4, 1922.	52.96			Small part of unit; heavy cut; much defect.
Mayo	IV	Sanatorium	400	706	1922	do		Wm. V. Gould, June 13, 1922.				Transferred to Roberts and McCullough.

Wind Cave	I	Bowman No. 1	833	2,396	1922	do		Frank Nihart, July 1, 1922.			
French Creek	V	Reynolds pasture	10	24	1922	do	1923	J. H. Mayberry, Aug. 14, 1922.	19.6		70
Pleasant Valley	V	Nellie Merchant	450	1,100	1922	do		Myren O'Connor, Sept 5, 1922.			
French Creek	V	White Spar	30	40	1922	do	1923	J. W. Hanes, Dec. 18, 1922.	67.38		
Pleasant Valley	IV	S. 2, NE. 4, sec. 9, Ts. 4–4.	8	20	1922	Regular	1922	J. H. Mayberry, June 6, 1922.	25		
Cold Brook	III	Pearson	116	304	1923	(All remaining mature timber scattered.)		A. M. Boggs, Jan. 25, 1923.			
French Creek	V	116	150	200	1923	Regular (ocular estimate).		S. E. Ainslee, Feb. 2, 1923.			
Pleasant Valley	IX, X	Long Draw	6,153	11,773	1923	Regular		F. W. Ward, Mar. 2, 1923.			
French Creek	I	Custer Park No. 1	109	250	1923	do		W. O. Mayberry, Mar. 25, 1923.			
Haselrodt	I	Walsh No. 1	182	970	1923	do		J. H. Bostwick, June 28, 1923.			
Mayo	I	Suterland ranch	610	2,127	1923	Regular. (Reappraised area. Time extended.)		J. B. Barnes, May 12, 1920.			
French Creek	V	Susan placer No. 1	301	740	1923	Regular		Paul V. Rosse, Sept. 29, 1923.			
Do	V	E. 2, NW. 4, SE. 4, sec. 22, Ts. 3-4.	15	25	1923	Regular. (Isolated patches.)		Paul V. Rosse, Sept. 4, 1923.			
Cold Brook	I	Hay Draw No. 3	810	2,090	1922	Regular		L. D. Pitts, July 21, 1922.			
Willow	II	Maudlin No. 1	420	886	1923	Regular. Previous cutting before forest was established.)					
Mayo	II, IV	Sanatorium siding	1,123	4,363	1923	Regular					
Bugtown	III	Ilsley No. 1	436	940	1924	do					
Lower Hell Canyon.	III	Doran subunit No. 1	70	150	1924	Regular. (Brush to be burned.)					
French Creek	V	168	247	750	1924	Regular					
Pleasant Valley	III	Warren Gulch No. 2	336	1,000	1924	do					
French Creek	V	White Spar No 2	52	177	1924	Regular. (Winter logging.)					
Pleasant Valley	III	Warren Gulch No. 3	200	775	1924	Regular					
Cold Brook	III	Cumming	223	375	1924	do					
Do	IV	Jack Rabbit	244	659	1924	do					
Willow	V	Squaw Creek	630	1,663	1924	do					
Do	III	Brown ranch	116	250	1924	do					
French Creek	V	Ilsley No. 2	419	1,346	1925	Regular. (Contract should provide for removal of cordwood.)					
Mayo	IV	Merchant	424	1,638	1925	Regular. (Heavy cut resulting.)					
French Creek	V	124	340	1,200	1925	do					

Cutting budget, Custer working circle, Harney National Forest, period 1921 to 1930—Continued

Location			Plan				Record					Methods, remarks, and references
				Stand to be cut					Amount cut			
Block	Compartment	Unit	Government area	M feet b. m.	Year to start cut	Method, treatment, etc.	Time cut (year completed)	Sale	M feet b. m.	Cords	Cull logs, linear feet	
Cold Brook	I	Albertson No. 2	362	864	1925	Regular. (Heavy cut resulting.)						
Mayo	III	Norberg South	249	955	1925	Regular. (Includes small area of Nihart unit lying in 40's 11, 12, sec. 1.)						
Do	II	McKnight	150	778	1925	Regular						
Willow	III	Doran	410	1,225	1925	do						
Pleasant Valley	VI	Wolf	717.2	2,007	1925	do						
French Creek	III	Sousan placer No. 2	180	693	1926	do						
Do	III	Sousan placer No. 3	516	1,960	1926	do						
Do	III	H. T. Graves	571	1,878	1926	do						
Willow	III	Smith	447	1,383	1926	do						
Do	III	Berkland	528	2,014	1926	do						
Wind Cave	IV	Hayden	70	230	1926	do						
Mayo	IV	Ayres	370	1,657	1927	do						
Cold Brook	I	Akes	35	66	1927	do						
Do	III	Blue Jay	286	445	1927	do						
Do	III	Carrol Creek	327	790	1927	do						
Do	IV	Cold Brook	399	949	1927	do						
Do	IV	Broadhead	437	898	1927	do						
Do	III	Loring	133	41	1927	do						
Do	IV	Hunter	76	187	1927	do						
Mayo	III	Upper Beaver	308	1,207	1927	do						
Cold Brook	IV	Pringle	78	201	1927	do						
French Creek	IV	Crow Creek	968	3,659	1928	do						
Total			24,182	64,819								

REVISION OF PLAN

A general revision of this plan will be made for every 10-year period and at the end of each cutting cycle. Minor revisions will be made every five years if conditions make it necessary. During the first 10-year period it will probably be necessary to check over and revise the plan at more frequent intervals, as more accurate data are obtained, or as points of importance are brought out that have been overlooked in the original plan.

Except as mentioned under "Cutting budget for 1921–1930," any changes or revisions made must have the approval of all officers approving the original plan.

There will be needed for the first revision of this plan:

1. More accurate data on areas and volumes of merchantable forest in those parts of the circle not covered by intensive surveys at the present time.
2. A check on the accuracy of the growth figures obtained by Johnson in 1921–22.
3. Additional figures showing actual volume left per acre in trees 10 inches and over d. b. h. on cut-over areas.

APPENDIX, CUSTER WORKING CIRCLE

Editorial note.—In addition to the tables here given the Appendix in the plan as submitted contains the following:

Description of working circle by blocks.
Marking rules for western yellow pine in the Black Hills and Harney National Forests.
Superseded marking rules for western yellow pine in the Black Hills and Harney National Forests in effect previous to 1923.
Volume table for western yellow pine in the Black Hills and Harney National Forests, by J. V. Leighou, 1916.
Normal increment in board-feet western yellow pine in the Black Hills and Harney National Forests, by Notestein, Smith, Phillips, and Bates.
Volume of national forest timber cut in Custer working circle by commercial saw-timber operators for the fiscal year 1923.

AREAS AND ESTIMATES (HOW OBTAINED)

Areas.—Figures given for the areas of various types were obtained from timber-survey data where such were available. For the areas not covered by timber surveys, data were taken from the land-classification maps by planimeter. Only approximate accuracy was obtained where the land-classification maps were used, since little or no distinction is made between the various forest types, such as reproduction, poles, and merchantable timber. The acreages obtained were divided among the various types in accordance with the best judgment of persons familiar with the region.

Estimates.—Estimates were obtained from timber-survey data where such were available. These data were available for the following areas:

T. 2 S., R. 3 E., sections 25 to 36, inclusive.
T. 2 S., R. 5 E., except sections 30 and 31.
T. 3 S., R. 3 E., all.
T. 3 S., R. 5 E., except sections 6, 7, 18, 19, 30, and 31.
T. 4 S., R. 4 E., except sections 1, 2, 3, 5, and 6.
T. 4 S., R. 5 E., all.
T. 5 S., R. 3 E., sections 1, 2, 11, 12, 13, and 14.
T. 5 S., R. 5 E., all.
T. 5 S., R. 4 E., all.
T. 4 S., R. 3 E., all.

For all other parts of the circle only land-classification data were available.

The timber-survey estimates are reasonably accurate. The land-classification estimates are very rough, usually ocular and not sufficiently detailed to be of great value.

Since land-classification figures were used for almost half of the area within the circle, the area and volume figures obtained can not be regarded as thoroughly reliable. Hence a safety factor has been allowed in arriving at the allowable annual cut.

GROWTH AND YIELD

Fred Johnson, of the Denver office of the Forest Service, made detailed growth studies in 1921–22 on areas in the Black Hills that were cut over under Forest Service regulation 10 to 20 years ago. His final report is not yet available, but according to figures in his preliminary report, there is a volume increase on the average acre of 49.2 per cent at the end of the tenth year after cutting. At the end of the twentieth year the volume increase is 116 per cent.

Assuming that for the remaining 15 years of the 35-year cutting cycle the growth continues at the same rate as between the tenth and twentieth years, the total volume increase on the average acre for the 35 years following the first cut will be 254.78 per cent.[3] (See Table 4.) The volume on the area at the time the second cut begins will then be as follows (rounding off the increment per cent to 254 per cent):

Volume per acre, feet b. m.

Cutting cycle	Average original stand	Amount cut,[1] 70 per cent	Amount left, 30 per cent	Increment on stand left, 254 per cent	Stand next cut	70 per cent to [1] cut next cycle
35 years--	5,623	3,936	1,687	4,285	5,972	4,180

[1] Based on 8,619 acres containing merchantable timber, where 33,921,200 feet b. m. were cut.

ROTATION AND CUTTING CYCLES

Studies made by Notestein in uncut stands of Black Hills western yellow pine show that the average silvicultural rotation is 160 years in virgin stands. Notestein's studies have been recently supplemented by those of Johnson. The latter studied cut-over areas.

Johnson's figures show that after the first cut in the virgin stand there is a substantial increase in the rate of growth of the trees left on the area. This increase is so marked that we are apparently justified in setting the length of rotation at 140 years, with four cutting cycles of 35 years each. At any rate, we are safe in using a period of 35 years for the first cutting cycle, as is shown by the following:

It seems safe to assume that the rate of diameter growth attained between the tenth and twentieth years after cutting will continue for at least 15 years more. Then, at the beginning of the second 35-year period, trees which were 10 inches d. b. h. at the time of the first cut will have attained a diameter of 13.5 inches, and trees which were 12 inches will have increased to 15.5 inches d. b. h. There will be at least 16 trees whose diameter will be 15 inches or more (see Table 3). On the assumption that these trees average the usual three logs per tree, they will produce a volume of 4,019 feet when cut, as is shown in the following tabulation:

Volume at beginning of second 35-year period

Diameter class	3-log volume per tree	Trees per acre	Indicated volume per acre
	Feet b. m.	*Number*	*Feet b. m.*
15-inch	200	7.21	1,442.00
16-inch	225	4.41	992.25
18-inch	300	3.37	1,011.00
20-inch	395	1.22	481.90
22-inch	485	.19	92.15
Total		16.40	4,019.30

This is 161 feet less than the estimated cut for the next cycle, as given in calculation of "Volume per acre" under "Growth and yield." Sufficient vol-

[3] There is a divergence of opinion on the reaction that is obtained in the form of increased growth after the first cut. However, it has been proved that there is a marked increase in growth, and further data will be obtained. If it is shown by future studies that the increased growth does not continue to the end of the 35-year cutting cycle it may be found necessary to cut the increment per cent figure down, since it is desired to obtain maximum growth at all times. Growth in young stands can be increased many times over that now being obtained when economic conditions make it possible to thin such stands properly. It is thought that such thinnings can be started within 10 years.

ume will be obtained from trees less than 15 inches that are defective, suppressed, or otherwise in need of cutting, to more than make up this difference.[4]

The marking rules now followed in the Black Hills forests call for the removal of 70 per cent of the stand by volume, on the average. An inspection of cut-over areas in this circle leaves no doubt in the observer's mind that a second cut can be made in 35 years which (barring insects, fire, etc.) will yield all of the volume expected.

CALCULATION OF ALLOWABLE CUT

A good stand of poles or reproduction, or of both, is generally found under the mature stand. It is estimated that 75 per cent of the area bearing merchantable timber carries an understory of both reproduction and poles. Hence, age classes 3a and 3b will not have to be carried in the stand any longer than 70 years to prevent a hiatus in the supply of timber ready for cutting. This is brought out more clearly by the following calculations:

Table 1 shows that there is now an area of 109,838 acres bearing merchantable timber. On this area there is a volume in trees 10 inches and over d. b. h. of 468,969,000 feet board measure. In the first cutting cycle, approximately 70 per cent by volume of this stand will be removed. This volume will come from the mature, decadent, and defective trees. The calculation included under "Growth and yield" indicates that at the beginning of the second cutting cycle more volume can be cut than was removed during the first cutting cycle. This second cut will be obtained from the almost mature trees left at the time of first cut, and from the most mature of what are now thrifty intermediates.

By the end of the second cutting cycle 70 years will have elapsed. During this period the poles that were on the area at the time of the first cut will have increased in d. b. h. at an average rate of 1 inch every 10 years (refer to Table 3) and there should be at least 16 averaging 15 inches or over, d. b. h. Such a stand will be found on 75 per cent of 109,838 acres, or on 82,378 acres. In addition there is an area of 28,008 acres of pole stands, with reproduction underneath, that will contain mature timber at the time of starting the third cutting cycle. There will then be a total area of 110,386 acres from which to obtain the third cut of the rotation.

The fourth cut of the rotation will be obtained from the area of 29,412 acres now bearing reproduction, and from 75 per cent of the area now bearing merchantable timber, or 82,378 acres. Thus the total area that can be cut over during the last cutting cycle will be 111,790 acres, with a strong probability of an additional area from the 28,008 acres of present pole stands.

CALCULATION AND CHECK ON VOLUMES TO BE CUT

First cutting cycle.—At the present time (1923) 109,838 acres in this circle bears a stand of timber in trees the majority of which are 10 inches or over in diameter. Owing to the large amount of mature and decadent timber on this area, it is imperative that it be cut over in the first 35-year cutting cycle. This will necessitate cutting an area of 3,138 acres annually. The total volume in trees over 10 inches d. b. h. on this area is 468,969,000 feet b. m. Seventy per cent, or 328,278,000 feet will be cut. This is equivalent to 2,988 feet b. m. per acre. Rounding this figure off to 3,000 feet, the indicated annual allowable cut for the first cutting cycle is 9,414,000 feet b. m. annually.

Using Von Mantel's formula for a check on this figure, the following result is obtained:

Total volume of stand (468,969,000 feet) divided by one-half the rotation (70 years) equals 6,699,000 feet b. m.—the indicated annual cut allowable according to this formula.

In view of the discrepancy between these two calculations the figure obtained by Von Mantel's formula is rounded off to 7,000,000 feet b. m., and this figure is fixed as the maximum allowable annual cut for the first cutting cycle, subject to change at such time as additional data may show that a change is justified.

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[4] It is not intended here to convey the idea that all trees over 15 inches d. b. h. will necessarily be cut. Marking in all cases will be guided by the standard marking rules. It happens, however, that most trees over 15 inches d. b. h. are ready for cutting, and this gives a basis on which to check the next cut.

Second cutting cycle.—Volume remaining after 70 per cent cut in first cutting cycle is 140,691,000 feet, on 109,838 acres.

Increment on above stand at an average rate of 150[5] board feet per acre per year is 476,649,500 feet b. m.

Total volume from which to obtain second cut is 617,340,500 b. m.

Expected yield (70 per cent cut) 432,138,350 feet b. m.

Third cutting cycle.—This cut will come from an area of 28,000 acres of present pole stands and from 82,378 acres of the area now bearing merchantable timber and poles. This gives a total area of 110,386 acres. There should be a volume of accrued increment of 579,526,500 feet (even allowing a 50 per cent loss for death and decay on the area of the present pole stands). There should also be thinnings from other stands.

Fourth cutting cycle.—This cut will come from 29,412 acres now in reproduction and from an additional area of 82,378 acres now bearing reproduction and poles under mature timber.

Total area to be cut over in fourth cycle is 111,790 acres. This should furnish a cut at least equal to that obtained in the third cutting cycle.

While the estimates of future yield are based on figures that are at best only approximately accurate, these checks show that there is no danger of a hiatus as the result of the use of the sustained yield figure of 7,000,000 feet annually during the first cutting cycle.

The cutting cycles will include the following years during the first rotation:

First cycle, 1921 to 1955, inclusive.
Second cycle, 1956 to 1990, inclusive.
Third cycle, 1991 to 2025, inclusive.
Fourth cycle, 2026 to 2060, inclusive.

TABLE 1.—*Areas and volumes for Custer working circle*

[The following area and volume table has been taken from the best available data. The figures for volume are for western yellow pine, the only merchantable species]

Block name	Forest-producing area					Volume, trees over 10 inches d. b. h.	
	Inaccessible	1–20 reproduction	20–80 pole stand	80 merchantable	Total forest-producing area	Accessible	Inaccessible
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*M. bd. ft.*	*M. bd. ft.*
Willow	1.4	1,939.5	1,275.5	9,090.8	12,305.8	38,745.8	6.5
French Creek	385.0	1,314.6	902.2	9,602.3	11,819.1	41,249.0	746.0
Bugtown		1,533.9	3,204.5	2,343.6	7,082.0	8,641.2	
Upper Hell Canyon		4,822.8	9,511.9	2,691.8	17,026.5	7,966.9	
Lower Hell Canyon [a]		2,360.0	3,534.4	21,257.8	27,152.2	56,949.8	
Pass Creek [a]		1,044.6	1,776.2	2,903.3	5,724.1	5,229.6	
Hawkwright [a]		345.4	680.4	1,758.0	2,783.8	3,622.0	
Pleasant Valley [a]		4,761.8	4,157.5	26,111.9	35,031.2	121,734.5	
Cold Brook		3,205.7	1,323.9	7,281.8	11,811.4	27,657.5	
Mayo	7.4	1,818.0	741.6	7,825.4	10,385.0	44,969.2	49.3
Haselrodt		771.4	372.0	6,095.2	7,238.6	40,432.4	
Flynn Creek		137.9	61.7	3,132.5	3,332.1	20,973.8	
Wind Wave		5,356.0	466.3	9,744.0	15,566.3	50,797.8	
Total	393.8	29,411.6	28,008.1	109,838.4	167,258.1	468,969.5	801.8

[a] Data not based on timber surveys. Figures only approximate.

[5] Johnson's figures indicate that the average annual increment per acre for the first 20 years after cutting is slightly over 168 feet b. m. In order to be conservative for the 35-year period, 150 feet per acre is adopted here.

TABLE 2.—*Stand, volume, and volume increment*

[Taken from F. R. Johnson's preliminary report of July 23, 1923, "Effect of thinnings—Black Hills yellow pine"]

Average acre, cut-over lands, western yellow pine, Black Hills region. Bases, 21 plots. Total acreage 5.33.

At time of cutting			10 years after cutting			20 years after cutting [1]		
D. b. h.	Trees	Volume	D. b. h.	Trees	Volume	D. b. h.	Trees	Volume
Inches	*Number*	*Board feet*	*Inches*	*Number*	*Board feet*	*Inches*	*Number*	*Board feet*
1	8.62							
2	12.94		2					
3	12.94		3	8.62				
4	17.81		4	12.94		4	8.62	
5	15.93		5	12.94		5	12.94	
6	17.06		6	17.44		6	12.94	
7	14.62		7	15.37		7	17.44	
8	12.75		8	16.50		8	15.37	
9	.75		9	14.06		9	16.50	
10	10.87	597.85	10	12.75	701.25	10	14.06	773.3
11	9.18	688.50	11	10.87	815.25	11	12.75	956.2
12	5.81	581.00	12	8.81	881.00	12	10.87	1,087.0
13	3.38	422.50	13	5.62	702.50	13	8.81	1,102.5
14	1.50	232.50	14	3.19	494.45	14	5.62	871.1
15	.56	106.40	15	1.50	285.00	15	3.19	606.1
16	.94	216.20	16	.56	128.80	16	1.50	345.0
17			17	.94	258.50	17	.56	154.0
18	.19	60.80	18			18	.94	300.8
			19	.19	71.25	19		
						20	.19	82.6
Total	145.85	2,905.75		142.3	[2] 4,338.00		142.30	[3] 6,278.6

[1] This represents the composition and volume of the stand at the time the study was made.
[2] 49.2 per cent volume increase.
[3] 116 per cent volume increase.

TABLE 3.—*Stand table*

[Derived from Table 2]

Average acre cut-over land, western yellow pine, Black Hills, S. Dak. Basis, 21 plots. Total plat acreage, 5.33.

D. b. h.	Known			Predicted			D. b. h.
	Time of cutting	10 years after cutting	20 years after cutting	30 years after cutting	35 years after cutting	40 years after cutting	
Inches	*Number of trees*	*Number of trees*	*Number of trees*	*Number of trees*	*Number of trees*	*Number of trees*	*Inches*
1	8.62						
2	12.94						
3	12.94	8.62					
4	17.81	12.94	8.62				
5	15.93	12.94	12.94	8.62	4.31		5
6	17.06	17.44	12.94	12.94	10.78	8.62	6
7	14.62	15.37	17.44	12.94	12.94	12.94	7
8	12.75	16.50	15.37	17.44	15.19	12.94	8
9	.75	14.06	16.50	15.37	16.41	17.44	9
Subtotal	113.42	97.87	83.81	67.31	59.63	51.94	
10	10.87	12.75	14.06	16.50	15.94	15.37	10
11	9.18	10.87	12.75	14.06	15.28	16.50	11
12	5.81	8.81	10.87	12.75	13.40	14.06	12
13	3.38	5.62	8.81	10.87	11.81	12.75	13
14	1.50	3.19	5.62	8.81	9.84	10.87	14
15	.56	1.50	3.19	5.62	7.21	8.81	15
16	.94	.56	1.50	3.19	4.41	5.62	16
17		.94	.56	1.50	2.34	3.19	17
18	.19		.94	.56	1.03	1.50	18
19		.19		.94	.75	.56	19
20			.19		.47	.94	20
21				.19	.09		21
22					.10	.19	22
Subtotal	32.43	44.43	58.49	74.99	82.67	90.36	
Total	[1] 145.85	142.30	142.30	142.30	142.30	142.30	

[1] This figure is larger than the rest because trees which have since died or have been wind thrown are included.

TABLE 4.—*Stock table*

[Derived from Tables 2 and 3]

Average acre cut-over land, western yellow pine, Black Hills, S. Dak.

D. b. h.	Volume per acre					Volume per tree
	Known			Predicted [1]		
	Time of cutting	10 years after cutting	20 years after cutting	30 years after cutting	35 years after cutting	
Inches	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
10	597.85	701.25	773.3	907.50	876.70	50
11	688.50	815.25	956.2	1,054.50	1,146.00	75
12	581.00	881.00	1,087.0	1,275.00	1,340.00	100
13	422.50	702.50	1,102.5	1,358.75	1,476.25	125
14	232.50	494.45	871.1	1,365.55	1,525.20	155
15	105.40	285.00	606.1	1,067.80	1,369.90	190
16	216.20	128.80	345.0	733.70	1,014.30	230
17		258.50	154.0	412.50	643.50	275
18	60.80		300.8	179.20	329.60	320
19		71.25		352.50	281.25	375
20			82.6		204.45	435
21				95.00	45.00	500
22					57.00	570
Total	2,905.75	4,338.00	6,278.6	8,802.00	10,309.15	
Volume increase, per cent		49.2	116.07	202.9	254.78	

[1] On basis of number of trees per acre and average volume per tree.

TABLE 5.—*Volume increment per acre per annum for stand left after cutting* [1]

D. b. h.	After cutting		At time of cutting	
	Trees per acre	Volume increment	Trees per acre	Volume increment before cutting [2]
Inches	*Number*	*Cubic feet*	*Number*	*Cubic feet*
1			8.62	
2			12.94	
3			12.94	
4	8.62	0.1724	17.44	0.0872
5	12.94	0.3882	15.37	.2305
6	12.94	0.6470	16.50	.363
7	17.44	1.3080	14.06	.4499
8	15.37	1.6138	12.75	.6375
9	16.50	2.3925		
10	14.06	2.9526	10.87	1.087
11	12.75	3.5700	8.81	1.2334
12	10.87	4.0219	5.62	1.0959
13	8.81	4.0526	3.19	.8294
14	5.62	3.0910	1.50	.5025
15	3.19	2.0735	.56	.238
16	1.50	1.1325	.94	.4860
17	.56	0.4816		
18	.94	0.9118	.19	.1358
19				
20	.19	0.228		
Total	142.3	29.0374	142.3	7.3761

[1] From Johnson's preliminary report, "Black Hills yellow pine, effect of thinnings." P. 4a.

[2] The volume increment in this computation is based on the diameter of the trees as they existed at the time of cutting as derived from the table showing diameter accretion. In this case the 4, 5, and 6 inch diameter classes would be 1, 2, and 3 inches and show no volume since cubic increment was not secured for trees less than 4 inches d. b. h. In the last column, only increment on the trees left in cutting is considered.

MANAGEMENT PLAN FOR MEADOW VALLEY WORKING CIRCLE, PLUMAS NATIONAL FOREST, CALIF.

Respectfully submitted.

JOHN S. EVERITT,
Forest Assistant.

Approved October 10, 1922.

D. N. ROGERS,
Forest Supervisor.

Approved March 3, 1923.

PAUL G. REDINGTON,
District Forester.

Approved, subject to the acting forester's letter of this date, March 30, 1923.

E. E. CARTER,
Acting Forester.

SUMMARY

LOCATION

Northern Sierra region of California. Parts of Tps. 23, 24, and 25 N., Rs. 8 and 9 E., M. P. M.

AREA

	Acres
Government land	28,805.25
Private land	9,189.91
Total acreage	37,995.16

STAND

	Board feet
Government	797,627,000
Private	158,519,000
Total stand	956,146,000

Composition:	Per cent
Sugar pine	21.8
Western yellow pine	26.6
Douglas fir	28.4
White fir	17.0
Incense cedar	6.2

ROTATION

One hundred years; cutting cycle, 50 years.

PERCENTAGE OF STAND TO BE REMOVED DURING FIRST CUTTING CYCLE

	Per cent
Government	80
Private	95

LIMITATION OF CUT

Sixteen million board feet per year.

FIRST CUTTING BUDGET, 1923–1933

	Board feet
Government	92,000,000
Private	68,000,000
Total	160,000,000

PREDICTED SECOND CUT

Eight million to nine million board feet per year.

INTRODUCTION

The Meadow Valley working circle embraces an almost ideal area for the institution of forest management. (See map.) It is a distinct, clear-cut unit. It includes sufficient area and timber to support a moderate-sized operation. One owner, the United States, has title to over 80 per cent of the stumpage and can thus control the time, place, method, and amount of cutting.

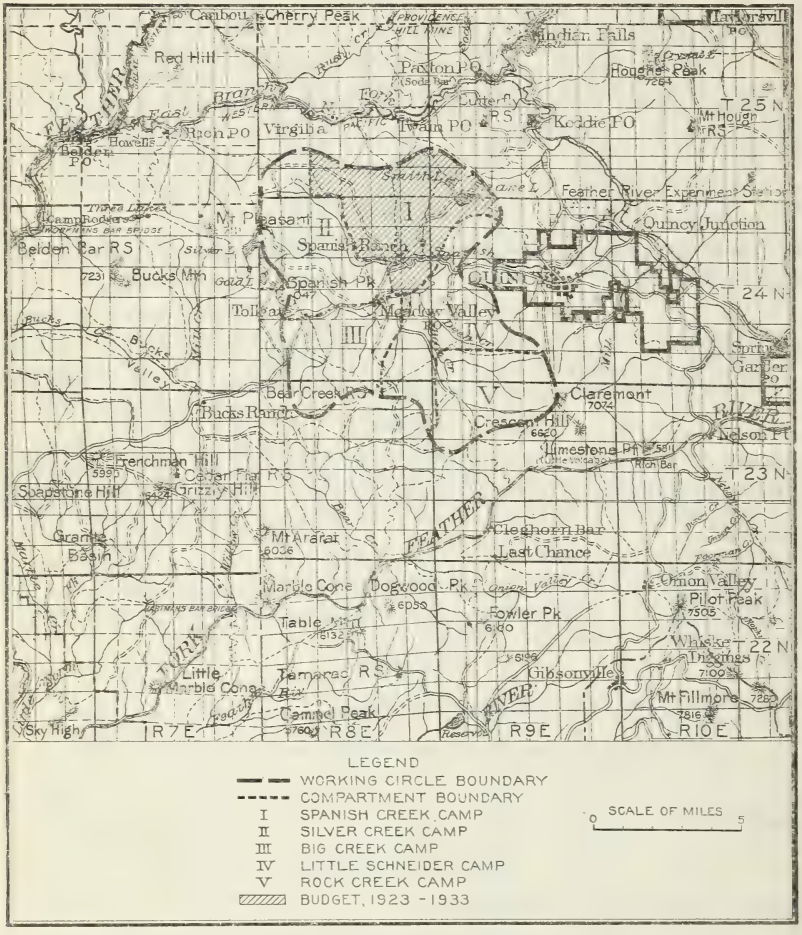

FIG. 2.—Meadow Valley Working plan, Plumas National Forest, Calif.

The purposes of this plan are:

1. To bring together all the available data concerning this unit which are necessary for the institution of forest management.

2. To determine the time, place, and amount of cutting which will best serve the interests of the United States and ultimately place the area on a sustained yield basis.

Calculations of yield and regulation of cut are of necessity crude, because of the lack of growth data on mixed stands, and particularly the lack of knowledge in regard to the effect of cutting on the remaining stand. Data used and results obtained are thought to be conservative and should serve their purpose until events and more data make a revision of the plan necessary.

DESCRIPTION OF WORKING CIRCLE

PHYSIOGRAPHIC FEATURES

Location.—This working circle, a subdivision of the Plumas National Forest, is about 8 miles west of Quincy, the county seat of Plumas County, Calif.

Acreage.—An area of 37,995.16 acres is embraced within the boundaries of this working circle. The Government controls 28,805.25 acres, and 9,189.91 acres are privately owned. On the 9,189.91 acres of private land 6,389.30 acres are controlled by the Spanish Peak Lumber Co.

Topography.—The area comprising this working circle lies in a natural basin formed by Spanish Creek and its various tributaries. Meadow Valley occupies the center of the area and is surrounded by high ridges and summits on all sides, except the east, where Spanish Creek leaves Meadow Valley and runs into American Valley. The area is considerably cut up by several streams with deep canyons.

The elevation ranges from 3,700 in the valley to about 5,200 feet on the high ridges. This rise in elevation takes place in a horizontal distance of less than 3 miles.

With the exception of the ridge tops and serpentine areas, the soil is generally of good depth and quality and contains a plentiful supply of moisture.

THE FOREST

The forest on this area is composed of a mixed stand of the following species:

	Per cent
Sugar pine	21.8
Western yellow pine	26.6
Douglas fir	28.4
White fir	17.0
Incense cedar	6.2

Types.—The major portion of the area is covered by a mixture of the species mentioned in the foregoing paragraph in various proportions. For the purpose of this plan it is unnecessary to make a fine distinction as to types, based on the proportion of different species present. Accordingly, only the following types or conditions have been recognized. Summarized for the Government and private lands they are, in acres:

	Timber	Cut over	Grazing and farm	Brush	Total
Government	25,787.25	1,305	30	1,683	28,805.25
Private	7,246.91	583	1,130	230	9,189.91
Total	33,033.16	1,888	1,160	1,913	37,995.16

The stand per acre on the timbered type and the total stand, Government and private, are:

	Stand per acre	Total stand
	Board feet[k]	*Board feet*
Government	30,745	792,827,000
Private	22,535	163,319,000
Total		956,146,000

Site classes.—Lack of growth data makes the division of the area into detailed site classes of little use at the present time. Two site classes, conforming to the standards for site Classes II and III, have accordingly been recognized. There is a narrow fringe of true Class I around the valley. This, however, forms such a small percentage of the total acreage that for the purpose of this plan it has been combined with Site II. The range of tree heights

for the various site classes is: Site I, over 175 feet; Site II, 125 to 175 feet; Site III, under 125 feet.

The area has been divided into site classes, as follows:

	Site II acreage		Site III acreage	
	Cut over	Virgin	Cut over	Virgin
Government	1,305	22,427.25		3,360
Private	520	7,096.91	53	150
Total	1,825	29,524.16	53	3,510

Rate of growth.—In the virgin stand growth is practically at a standstill. The cruise shows that 2½ per cent of the timber is dead. The annual loss would, therefore, probably offset any increase in growth which the stand might make.

Growth data taken on cut-over areas show that in Site II, with a reserve stand averaging close to 5,000 board feet, the mean annual growth is about 200 board feet per acre.

On Site III, with a reserve stand of about 1,500 board feet, the rate of growth is about 30 board feet per acre per year.

ECONOMIC SITUATION

PRESENT AND FUTURE MARKETS

Disposal of the lumber from this area is dependent upon the general market. At the present time the upper grades of pine and Douglas fir go to the eastern market. The lower grades, particularly box lumber, are taken by the California market. Markets will probably be much the same in the future as at present, the East taking the better grades, and the steadily growing box industry of California the lower grades.

LABOR SUPPLY

Floating labor must be depended upon to furnish the greater part of the labor supply for this area. Because of climatic conditions winter work is impracticable; so there is no incentive for labor to become established. The present operation employs from 150 to 175 men. Less than 20 per cent of these are local residents.

POPULATION AND LOCAL NEEDS

The population adjacent to and within this working circle is very small Agriculture and dairying on a small scale are the principal occupations. The uncut and cut-over timbered land will furnish a plentiful supply of wood for fuel; so it is not necessary to lay off local-use areas.

TRANSPORTATION

An aerial tramway 5.1 miles in length connects this area with the Western Pacific Railroad at Grays Flat. Direct rail connections would have to be made by way of Quincy with the Quincy Railroad. This would necessitate the building of about 8 miles of railroad, partly on a canyon slope where construction would be expensive.

PRESENT MILLS

The present mills consist of one single band mill of 65,000 board feet daily capacity, located at Spanish Ranch, and one circular mill of about 30,000 board feet daily capacity, located on Slate Creek. Both mills are owned by the Spanish Peak Lumber Co., but only the band mill is operated at present.

SILVICULTURAL POLICY

OBJECTIVES

1. To produce saw timber suitable for the general market.
2. To remove the mature and decadent timber in as short a time as possible and at the same time to provide for a second cut of sufficient size to make a profitable operation.
3. To leave the area in the best condition for ultimately putting the forest on a sustained yield basis.

ROTATION

A rotation of 100 years has been accepted as the basis for management until such time as yield studies can be made to determine the proper rotation. A growth study made on cut-over lands indicates that the established reproduction will reach saw-timber size within this period.

CUTTING CYCLES

There will be two cutting cycles of 50 years each. For the first cutting cycle this will provide for an average cut, both Government and private, of about 23,000 board feet per acre. For the second cutting cycle the cut on Government land will be reduced to about 16,000 board feet per acre. The yield from private lands will be small during the second cutting cycle because of the fact that no provision can be made for a second cut.

MARKING

On Site II use the group selection and selection systems. The following rules are effective:

1. Leave all thrifty trees and the most promising of the thrifty-mature trees; that is, those which from appearances will continue to grow until the next cutting cycle.
2. Mark all mature and decadent trees.
3. Mark all dead, diseased, and green insect-infested trees.
4. Mark unusually tall trees and trees with very large crowns in situations exposed to severe winds.
5. Mark all trees which seriously interfere with the accepted logging plan.
6. The maximum opening should not exceed 2 acres.
7. Where possible, leave relatively large thrifty-mature sugar pine for quality increment.

On Site III leave only thrifty trees, except when these are insufficient for seeding purposes. The result will approach clear cutting with seed trees.

RESULTS OBTAINED ON PRESENT SALE

On the 1,305 acres of Government land cut over to date, the application of the above marking rules has resulted as follows:

	Per cent
Average cut per acre, 26,570 board feet	84.3
Average left per acre, 4,940 board feet	15.7

Future marking practice will follow the above rules, but in order to insure a satisfactory second cut will aim at leaving more of the thrifty mature trees. The result will be to cut about 80 per cent of the board-feet volume of the timber and to leave about 20 per cent. For the Government area the totals will be as follows:

	Per cent
Average cut per acre, 24,600 board feet	80
Average left per acre, 6,150 board feet	20

MANAGEMENT POLICY

OBJECTIVES

1. As is indicated in the policy statement for this area, this working circle is to be managed to supply a single manufacturing plant.
2. Alienated cut-over land available for exchange is to be acquired.

REGULATION OF THE CUT

With the data at hand, only a rough calculation of the annual cut can be made. For the first cutting cycle the annual cut is based on the following premises:

	Board feet
Total estimate for Government land	792, 827, 000
Amount to be cut during first cutting cycle, 80 per cent, or	634, 262, 000
Total estimate for private land	163, 319, 000
Amount to be cut during first cutting cycle, 95 per cent	155, 153, 000
Total amount to be cut	789, 415, 000

Cutting cycle	Total estimate	Amount to be cut	Annual cut
	Board-feet	*Board-feet*	*Board-feet*
50 years	956, 146, 000	789, 415, 000	15, 788, 000

An average annual cut of the rounded-off figure of 16,000,000 board feet has accordingly been adopted and is considered sound for the following reasons:

1. It is thought to be conservative, inasmuch as the estimates, particularly on private land, are considered low.
2. It provides for the removal of all the mature and decadent timber within 50 years, and at the same time provides for a second cut of sufficient size to make a profitable operation.
3. It places the area in shape for the starting of sustained yield.

GENERAL PROGRESS OF CUT

The general progress of cut contemplates (1) the completion of the present sale, (2) the cutting of the remaining timber on the north side of the valley, (3) the cutting of the timber on the south side of the valley. In other words, the cut will proceed counter clockwise around the basin.

LAND EXCHANGE

Of the 9,189 acres of patented land within the working circle, less than 4,000 acres will be available for land exchange. Over 60 per cent of the patented land was taken up through mineral and homestead entries and can not, therefore, be taken over by the Government under the present exchange law.[6] The land available for exchange should be acquired by the Government as soon as practicable after it is cut over.

CUTTING ON PRIVATE LANDS

Future production from this working circle will be strongly influenced by the condition in which the private land is left after the first cutting. This will be pointed out to those in control of lumbering on these private lands, and they will be urged to (1) fall all snags; (2) dispose of brush by piling, or at least by scattering the brush and protecting the area by fire lines; (3) preserve young growth in logging; (4) provide adequate fire protection while logging; and (5) leave at least four trees per acre 18 inches d. b. h. or over.

The carrying out of these measures will keep the land in productive condition and provide for at least one cut for the rotation period.

TIMBER-SALE POLICY

Under this plan the timber sale policy will include the following:

1. Provision for sales to supply the established industry with a continuous cut, so far as is possible under the procedure and policy existing at the time of sale.

[6] The exchange law was amended in 1925 to allow the reservation of mineral rights by either the proponent of an exchange or, if land instead of timber is the consideration, by the United States. The acreage desirable for acquisition by the Government in this circle has thus been increased, but the agricultural lands should remain in private ownership.

2. Limitation of the maximum annual cut on both Government and private timber to 16,000,000 board feet.
3. Completion of cutting on present sale area at a rate of 16,000,000 board feet per year.
4. Sale of remainder of timber on north side of area before any cutting starts on the south side.

NUMBER AND CAPACITY OF MILLS

One mill with a yearly capacity of 16,000,000 board feet will be required for this working circle. With an average logging season of about 150 days, this means a daily cut of about 110,000 board feet. As a matter of conservation, the established industry will not be urged to increase its capacity at once to the amount of the indicated annual yield, but should it decide to increase its annual cut no objection will be raised.

SIZE AND PERIOD OF SALES

Sales will be made by the topographic units and for as long as a 10-year period. In size, any sale may equal the 10-year cut, or 160,000,000 board feet, as soon as the local industry can take care of that amount.

ORDER OF CUTTING BY COMPARTMENTS

(See accompanying map of working circle, fig. 2.)
1. Spanish Creek compartment or present sale area.
2. Silver Creek compartment.
3. Big Creek compartment.
4. Little Schneider Creek compartment.
5. Rock Creek compartment.

The reasons for this order of cutting are:
1. Since to date only the most accessible timber has been logged from the present sale area, the remainder of this unit should be logged first.
2. It keeps the cut-over area in a compact unit.
3. It provides for the logging of the entire north side of the working circle before the south side is started, so that in case anything happens to the operating company the south side of the area will be left intact.
4. It takes the more mature timber early in the cutting cycle.
5. It leaves the Rock Creek compartment with its high percentage of fir till the last.

BRUSH DISPOSAL

Tops will be lopped and brush piled and burned, as is now done. Up to the present time this has resulted in a satisfactory cleaning up of the area from a fire standpoint and has caused very little damage to the reserve stand.

UTILIZATION REQUIREMENTS

The present standard utilization requirements are applicable to this working circle, and for the first periodic sale at least no additional or special requirements are necessary.

FIRE-PROTECTION REQUIREMENTS

In order to insure sustained yield and the successful carrying out of this plan adequate fire protection is essential. This area, however, presents no serious fire hazard and the standard timber sale fire-protection requirements will be sufficient.

INSECT CONTROL

There are several small areas on the south side of the working circle that show recent insect infestation (*Dendroctonus brevicomis*). These areas should be watched, and if these infestations tend to become epidemic control measures should be promptly instituted.

LOGGING METHODS

Because of topographic conditions, this working circle is essentially a donkey-logging proposition. Transportation by railroad was originally planned for the

entire area, but up to the present time chutes and gas trucks have been used. It would seem that a railroad is desirable, particularly in logging the more inaccessible portions of the area. Until more data are accumulated on the size of operation requiring a railroad and as long as the operating company can show a profit by using trucks the Government is not in a position to dictate the method of transportation.

Cutting budget for 1923–1933

[Present sale extends to 1931]

Compartment	Amount to be cut		Total
	Government	Private	
	Board-feet	*Board-feet*	*Board-feet*
Spanish Creek	92, 000, 000	68, 000, 000	160, 000, 000

REVISION OF PLAN

A working plan must be revised at frequent intervals if it is to be workable and not become obsolete. Revision is essential when the original plan is based on rough data.

This plan should be revised at the termination of the first 10-year cutting period, if revision is not required before that time.

DATA NECCESSARY FOR REVISION OF PLAN

1. Division of the area into site classes, based on height of trees.
2. One hundred per cent estimate of trees over 4 inches d. b. h. left after cutting, and at least 1 per cent estimate of trees under 4 inches d. b. h.
3. Correction of estimate for both Government and private timber by checking stands cut and left against original estimate.
4. Yield study by sites on cut-over land to determine the rate of growth after release by cutting.

APPENDIX, MEADOW VALLEY WORKING CIRCLE

HISTORY OF WORKING CIRCLE

Timber exploitation within this circle started in 1913, at which time the Towle Lumber Co. constructed a mill of about 30,000 daily capacity on Slate Creek. This mill was operated by the company from 1913 to the middle of the season in 1915. During this time about 10,000,000 board feet of timber was cut.

In 1916 the Spanish Peak Lumber Co. was organized, with holdings of over 100,000,000 board feet within this unit. A mill of about 65,000 daily capacity was erected at Spanish Ranch. An aerial tramway was constructed to convey the lumber from the mill to the lumberyard at Grays Flat, which is on the main line of the Western Pacific Railroad.

In 1916 the Government made the present sale of 106,000,000 board feet to this company. Cutting of both Government and private timber has been continuous since that time.

In 1920 the company purchased the Towle Lumber Company's mill and private holdings, operating it in conjunction with their own mill during the entire season.

The cut by years for both Government and private timber from this unit is as follows:

Year	Government	Private	Year	Government	Private
	Board feet	*Board feet*		*Board feet*	*Board feet*
1913–1915		10, 000, 000	1920	4, 041, 000	6, 995, 000
1916	4, 376, 000	2, 007, 000	1921	5, 190, 000	2, 552, 000
1917	9, 587, 000	1, 651, 000			
1918	7, 563, 000	638, 000	Total	34, 570, 000	28, 028, 000
1919	3, 813, 000	4, 185, 000			

DISCUSSION OF CRUISE

The Government land on this area was cruised in 1910. The trees were tallied by 2-inch diameter classes, the number of logs per tree not being tallied. Volumes were computed from especially prepared volume tables. Trees from 12 to 20 inches d. b. h. were not tallied.

Checking the estimate for 1,300 acres of cut-over land against the cut and the amount left for the same area gives the following result:

	Board feet
Cut	34, 541, 000
Left	6, 425, 900
Total	40, 966, 900
Estimate	35, 928, 100
Difference	5, 038, 800
Underestimate ---------- per cent	12. 3

A comparison of the Forest Service cruise on 4,160 acres on the south side of the area with the cruise made by the University of California Forest School on the same area results as follows:

	Board feet
University of California Forest School estimate	151, 767, 000
Forest Service estimate	130, 720, 000
Difference [a]	21, 047, 000

A part of the underestimate of the Forest Service cruise was probably due to the fact that trees from 12 to 20 inches d. b. h. were not included.

FIRE HAZARD

This unit would be classed as an area of low fire hazard for the following reasons:

1. A heavy snowfall, with cool nights during most of the year, prevents a rapid drying out of the area.
2. The entire area is directly under the eye of the Spanish Peak lookout, so fires should be detected when small.
3. All parts of the area are readily accessible by roads and trails.
4. There is a good supply of labor close at hand.
5. The area is comparatively free from the two chief causes of fires—lightning and campers.

Summary of fire record for last 11 years

Year	Number of fires	Acreage burned	Year	Number of fires	Acreage burned
1911	2	0.5	1919	3	2
1912	4	12	1920	2	340
1913	8	16	1921	1	0
1914	8	160			
1915	1	0	Total	31	531
1916	0	0			
1917	1	.5	Average per year		48
1918	1	0			

On the basis of the fire record for the last 11 years the loss from fire during the first cutting cycle would not be heavy. A total of 2,400 acres would be burned over, but only part of this would fall on virgin timberland, and the loss on this should not be high. The main loss would come through the destruction of poles and advance reproduction. With the steady improvement in the fire-protection system, normal loss from fire should not seriously interfere with the plan for the institution of sustained yield.

GROWTH AND YIELD

Growth and yield data for mixed stands are very meager. The problem of predicting yield for the second cutting cycle and for the rotation period is

[a] 16.1 per cent of Forest Service estimate.

further complicated by lack of knowledge of the effect of the two cuttings on the stand.

In order to get some idea of what the yield from cut-over land might be in 50 years, 500 increment borings were taken on a mixed stand cut about 45 years ago. The results of this study were then applied to the reserve stand left on this working circle.

Table 2 shows the increase in diameter by 2-inch diameter classes for a 50-year period.

Application of these results to the stand and stock tables for the Government land cut over to date gives the following:

Volume per acre in board feet

Cutting cycle	Average original stand	Amount cut (84.7 per cent)	Amount left (15.3 per cent)	Increment on 12-inch d. b. h. trees left	Volume of pole stuff merchantable	Average stand at second cut
50 years	30,700	26,000	4,700	10,000	2,800	17,500

Under the provisions of this plan it is proposed to leave 20 per cent of the stand and remove 80 per cent. Under these conditions the resultant stand at the end of 50 years would be as follows:

Volume per acre in board-feet at the end of 50 years

Cutting cycle	Average original stand	Amount cut (80 per cent)	Amount left (20 per cent)	Increment on 12-inch d. b. h. trees left	Volume of pole stuff merchantable	Average stand at second cut
50 years	30,700	24,600	6,100	12,000	2,800	20,900

The above computations indicate that with a reserve stand of 6,100 per acre a stand of 20,000 or over would be produced in 50 years. This is not considered too much to expect, inasmuch as 90 per cent of the trees left are under 30 inches d. b. h., and with release from competition and suppression should take on increment rapidly. A cut of 16,000 per acre is therefore considered conservative for the second cutting cycle.

DISCUSSION OF ROTATION AND CUTTING CYCLES

Available growth data indicate that on a 100-year rotation a tree of at least 18 inches d. b. h. can be produced. The reproduction under 4 inches d. b. h. now on the ground should, in a 100-year period, be from 24 to 30 inches d. b. h. Figuring that logging during the second cutting cycle will destroy about one-half of the reproduction, there should be at the end of the first rotation a stand one-half stocked with trees from 18 to 30 inches d. b. h., with a small percentage of larger trees left for seeding purposes when the second cut is made. It would therefore seem safe to assume a rotation period of 100 years to start with.

In determining the length of cutting cycles to be adopted the following conditions were considered:

1. A rapid cutting over of the area, removing from 60 to 65 per cent of the volume. First cutting cycle, 35 to 40 years. Second, 60 to 65 years.

2. A slower cutting over of the area, removing from 80 to 85 per cent of the volume. Cutting cycles, 50 years each.

Advantages of rapid cutting.—Removes decadent and part of mature timber in from 35 to 40 years. Leaves heavier second cut more nearly approaching a sustained-yield basis.

Disadvantages of rapid cutting.—(*a*) From 15 to 20 per cent of timber left would be of mature and thrifty-mature classes. (*b*) Marking would be complicated. (*c*) A lighter cut per acre reduces the chance for a profitable operation at present..

Advantages of slow cutting.—(*a*) Removes all of the mature timber and most of the thrifty mature. (*b*) Provides for a greater growth on remaining stand because of more complete release. (*c*) Simplifies marking. (*d*) Insures a profitable operation at present.

Disadvantages of slow cutting.—(*a*) Makes a reduction in the second cut of from 40 to 45 per cent.

REGULATION OF THE CUT

Because of the maturity of the stand annual growth will not greatly exceed annual loss from old age, insects, windfall, etc. Determination of the annual cut by methods involving a detailed knowledge of increment was, therefore, not considered necessary.

In arriving at the annual cut the total amount to be cut, 787,646,000 board feet, was divided by the length of the cutting cycle, 50 years, giving an annual cut of 16,000,000 board feet.

FORECAST OF SECOND CUT

Basis:

23,732 acres, site class II.
20,000 board feet predicted stand per acre at end of 50 years.
474,640,000 board feet. Total stand at end of 50 years.
379,712,000 board feet stand to be removed during second cutting cycle.
379,712,000 divided by 50 equals 7,594,000 board feet or annual cut.

A cut of 7,500,000 feet from Site II, plus whatever excess may accumulate during the first cutting cycle, together with a small cut from Site III, should give a total second cut of from 8,000,000 to 9,000,000 feet per year.

In 50 years, with closer utilization and with the increase in the value of lumber, this should make a profitable operation.

TABLE 1.—*Stand by sections for Government and private land*

Township	Section	Government	Private	Township	Section	Government	Private
		M bd. ft.	*M bd. ft.*			*M bd. ft.*	*M bd. ft.*
23–8	1	9,118		25–8	32	8,386	
	2	2,021			33	5,485	
	3	6,917			34	10,530	
	4	10,360			35	7,183	11,320
	5	8,220			36		12,900
24–8	1	4,492	1,650	23–9	6	30,190	
	2	2,808	2,100		5	35,884	
	3	3,901	335		7	20,720	
	4	10,849			8	13,509	
	5	16,219			17	5,392	
	6	3,635			9	9,007	
	7	6,291			4	7,383	
	8	20,054			10	1,886	
	9	13,053	1,990		3	1,965	
	10	5,615	5,718		16		1,235
	11	2,762	435	24–9	6	16,685	1,585
	12	926	2,200		5	6,137	10,526
	13	8,202	7,560		4	1,153	
	14	1,219	5,291		7	10,002	2,035
	15		6,500		8	5,649	720
	16	12,353	850		18	1,302	4,250
	17	17,847			17	3,077	
	20	18,551			19	4,800	
	21	13,413	4,486		20	23,933	
	22	2,092	12,100		30	8,647	5,571
	23	2,558	9,400		21	4,275	
	24	5,224	4,700		29	21,926	
	25	18,401	13,460		28	14,869	250
	26	21,778	11,426		27	1,975	
	27	25,213	1,200		31	29,807	
	28	15,396	4,600		32	23,711	
	29	7,406	4,400		33	13,606	1,220
	32	7,302	2,820		34	7,146	
	33	15,841	1,120		27	1,975	
	34	13,936		25–9	30	5,927	
	35	25,618			31	15,546	655
	36	32,072			32	10,740	311
25–8	29	1,372					
	31	14,184	1,600			797,627	158,519

TABLE 2.—*Diameter growth for 50-year period after cutting*

[Based on 500 increment borings taken on stand cut over 45 years ago]

Present d. b. h. (inches)	D. b. h. in 50 years					Present d. b. h. (inches)	D. b. h. in 50 years				
	Sugar pine	Western yellow pine	Douglas fir	White fir	Incense cedar		Sugar pine	Western yellow pine	Douglas fir	White fir	Incense cedar
	Inches	*Inches*	*Inches*	*Inches*	*Inches*		*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
4	16	14	14	16	12	30	42	38	38	40	38
6	18	18	16	18	14	32	44	40	40	40	40
8	22	20	18	20	16	34	46	42	42	42	42
10	24	22	20	22	20	36	46	42	44	44	44
12	26	24	22	24	22	38	48	44	44	46	46
14	28	26	26	26	24	40	48	46	46	48	48
16	30	26	28	28	26	42	50	46	48	48	48
18	32	28	30	28	26	44	50	------	50	------	------
20	34	30	32	30	28	46	52	------	------	------	------
22	34	32	32	32	30	48	54	------	------	------	------
24	36	34	34	34	32	50	------	------	------	------	------
26	38	36	36	36	34	52	------	------	------	------	------
28	40	36	38	38	36	54	------	------	------	------	------

TABLE 3.—*Stand on average acre—cut-over land*

[Basis, 120-acre strip]

D. b. h. (inches)	Sugar pine	Western yellow pine	Douglas fir	White fir	Incense cedar	Total
	Number of trees	*Number of trees*	*Number of trees*	*Number of trees*	*Number of trees*	*Number of trees*
4	0.44	0.63	0.73	1.25	0.30	3.35
6	.34	.47	.99	1.19	.39	3.38
8	.16	.30	.71	.83	.14	2.14
10	.30	.27	.63	.83	.34	2.37
Subtotal	1.24	1.67	3.06	4.10	1.17	11.24
12	.33	.24	.34	.46	.36	1.73
14	.20	.40	.44	.52	.55	2.11
16	.19	.38	.32	.30	.28	1.47
18	.18	.21	.28	.16	.20	1.03
20	.11	.17	.26	.22	.33	1.09
22	.17	.22	.25	.36	.20	1.20
24	.19	.14	.23	.24	.14	.94
26	.16	.12	.18	.20	.07	.73
28	.07	.09	.10	.11	.04	.41
30	.12	.06	.09	.07	.10	.44
32	.10	.03	.08	.06	.07	.34
34	.06	.02	.03	.01	.01	.13
36	.01	------	.01	.01	.01	.04
38	.03	------	.01	------	.02	.06
40	.03	------	------	------	.01	.04
42	.03	------	------	.02	------	.05
44	------	------	------	------	------	.00
46	------	------	.01	------	.01	.02
48	.01	------	------	------	------	.01
Subtotal	1.99	2.08	2.63	2.74	2.40	11.84
Total	3.23	3.75	5.69	6.84	3.57	23.08

TABLE 4.—*Growing stock on average acre, cut-over land*

[Basis, 120-acre strip]

D. b. h. (inches)	Sugar pine	Western yellow pine	Douglas fir	White fir	Incense cedar	Total
	Board-feet	*Board-feet*	*Board-feet*	*Board-feet*	*Board-feet*	*Board-feet*
12	26.4	32.4	31.6	36.8	17.3	144.5
14	19.0	72.0	63.8	67.6	29.7	252.1
16	27.5	87.4	63.6	55.5	20.7	254.7
18	41.4	65.1	75.6	41.4	24.0	247.5
20	38.5	73.1	92.5	74.2	56.1	334.4
22	81.6	128.4	119.5	160.2	45.6	535.3
24	121.6	108.2	136.6	140.1	40.6	547.1
26	131.2	118.8	133.2	150.0	26.2	559.4
28	69.6	110.3	92.5	105.6	19.0	397.0
30	145.8	89.6	101.2	82.0	59.1	477.7
32	158.1	52.8	105.4	86.8	51.3	454.4
34	102.5	41.5	45.9	17.4	8.7	216.0
36	19.8		18.1	20.5	10.1	68.5
38	68.2		21.3		23.4	112.9
40	78.7				13.4	92.1
42	90.1			61.3		151.4
44						
46			34.5		19.2	53.7
48	44.9					44.9
50						
Total	1,264.9	979.6	1,135.3	1,099.4	464.4	4,943.6

TABLE 5.—*Predicted stand*

[Number of trees on average acre at end of 50 years]

D. b. h. (inches)	Sugar pine	Western yellow pine	Douglas fir	White fir	Incense cedar	Total
	Number of trees	*Number of trees*	*Number of trees*	*Number of trees*	*Number of trees*	*Number of trees*
12					0.30	0.30
14			0.73		.39	1.12
16	0.44	0.63	.99	1.25	.14	3.45
18	.34	.47	.71	1.18	.34	3.04
20		.30	.63	.83		1.76
22	.16	.27	.34	.83	.36	2.26
24	.30	.24		.46	.57	1.60
26	.33	.40	.51	.53	.50	1.94
28	.21	.60	.34	.30	.34	1.79
30	.19	.17	.29	.39	.20	1.24
32	.19	.23	.26	.36	.14	1.18
34	.28	.14	.55	.24	.11	1.32
36	.19	.22	.20	.21	.11	.93
38	.16	.06	.21	.11	.07	.61
40	.07	.03	.10	.03	.01	.24
42	.14	.03	.03	.01	.01	.22
44	.10		.02	.01	.03	.16
46	.07				.01	.08
48	.06			.03		.09
50	.03				.01	.04
52						
54	.01					.01
Total	3.27	3.79	5.91	6.77	3.64	23.38

TABLE 6.—*Predicted growing stock*

[Board feet on average acre at end of 50 years]

D. b. h. (inches)	Sugar pine	Western yellow pine	Douglas fir	White fir	Incense cedar	Total
	Board feet	*Board feet*	*Board feet*	*Board feet*	*Board feet*	*Board feet*
12					13.5	13.5
14			105.8		23.4	129.2
16	68.2	144.9	188.1	231.2	11.2	643.6
18	73.1	145.7	173.9	295.0	40.8	728.5
20		124.5	201.6	273.9		600.0
22	67.2	151.2	142.8	356.9	81.0	799.1
24	165.0	192.0		257.6	165.3	779.9
26	222.2	396.0	326.4	376.3	175.0	1,495.9
28	182.7	750.0	282.0	268.5	153.0	1,636.2
30	207.1	260.0	308.8	429.0	114.0	1,318.9
32	258.4	404.8	335.4	495.0	93.8	1,587.4
34	464.8	303.8	797.5	403.2	95.7	2,065.0
36	364.2	543.4	326.0	444.1	107.8	1,785.5
38	360.0	167.4	409.5	261.8	73.8	1,272.5
40	184.8	97.8	234.0	343.2	12.5	872.3
42	420.0	111.8	85.5	31.8	13.9	663.0
44	350.0		63.0	34.9	51.0	498.9
46	269.3				18.6	287.9
48	270.0			136.5	23.9	430.4
50	159.0					159.0
52						
54	67.9					67.9
Total	4,153.9	3,793.3	3,980.3	4,638.9	1,268.2	17,834.6

MANAGEMENT PLAN FOR THE WOODLAND WORKING CIRCLE, PIKE NATIONAL FOREST, COLO.

SUMMARY

LOCATION

From 12 to 35 miles northwesterly from Colorado Springs.

AREAS

	Acres
Gross area within national forest boundaries	117,573
Total national forest land	93,520
National forest land now timbered	82,910
Patented land	24,053

TIMBER, NATIONAL FOREST LAND ONLY

Saw timber	board feet	63,551,000
Railroad ties	pieces	799,000
Mine props	linear feet	50,752,000

SPECIES COMPOSING PRESENT VOLUME

	Per cent
Western yellow pine	50
Douglas fir	40
Engelmann spruce, limber pine, lodgepole pine, etc	10

CROP TO BE GROWN

Saw timber chiefly, with hewn ties, mine timbers and props, and other minor products cut from small mature trees, tops, thinnings, etc.

SILVICULTURAL SYSTEM

Selection.

MERCHANTABLE STAND TO BE CUT IN FIRST CUTTING CYCLE

Fifty-two million four hundred and thirty-eight thousand board feet, comprising 27,169,000 board feet of saw timber, 290,000 railroad ties, 16,669,000 linear feet of mine props.

LIMITATION OF CUT

Period 1926–1935

Volume: 6,793,000 board feet of saw timber, 72,500 railroad ties, 4,167,000 linear feet of mine props, equivalent to 13,110,000 board feet total.

Area check: 23,447 acres.

Annual average (volume): 680,000 board feet of saw timber, 7,250 railroad ties, 416,700 linear feet of mine props, equivalent to 1,311,000 board feet total.

PREDICTED CUT, FUTURE CYCLES

Two million one hundred and sixty-eight thousand board feet per year in second cycle and increasing amounts in succeeding cycles.

Submitted March 19, 1927.

H. K. PETHERAM, *Forest Examiner.*

Approved March 21, 1927.

E. S. KEITHLEY, *Forest Supervisor.*

Approved April 12, 1927.

ALLEN S. PECK, *District Forester.*

Approved April 23, 1927.

E. A. SHERMAN, *Acting Forester.*

Cutting budget, Woodland working circle, period 1926 to 1935, Pike National Forest

Compartment	Sub-unit	Area	Estimated volume to be cut			Year cutting to begin	Amounts sold by products (to be filled in as sales are made)		
			Saw timber	Railroad ties	Props		Saw timber	Ties	Props
		Acres	*Board feet*	*Number*	*Linear feet*		*Board feet*	*Number*	*Linear feet*
Beerkeg	1	200	80,000	3,000	24,000	1927			
	2	380	79,000	6,000	105,000	1926	79,000	6,000	105,000
	3								
Fern	1	865	900,000	18,000	540,000	1927			
	2	753	798,000	18,000	212,000	1928			
Missouri [1]	13	2,075	743,000	2,000	1,261,000	1929			
	14	880				1929			
	1	510							
	2	1,200							
	3	250	1,200,000	12,000	1,000,000	1930			
	4	250							
	5	750							
	6	300							
Hotel [1]	1	570							
	2	600	100,000	1,000	25,000	1931			
	3	580							
Johns [1]	1	500							
	2	500							
	3	850	500,000	3,000	50,000	1932			
	4	700							
Crystola [1]	1	300							
	2	700							
	3	600	500,000	4,000	250,000	1933			
	4	1,100							
Catamount	1	241	143,000	3,000	82,000	1934			
	2	663	374,000	10,000	300,000	1934			
	3	273	165,000	5,000	174,000	1934			
Orchette [1]	All.	900	150,000	2,000	500,000	1934			

[1] Rough estimate of timber available for cutting during the budget period; will be cruised later.

Sales record, Woodland working circle, Pike National Forest

Sale No.	Compartment and subunit	Case designation	Status of sale completed, abandoned, canceled	Sale closed (year)	Cut			Silvical method followed	Remarks, including predicted time of next cut
					Props	Ties	Saw timber		
					Linear feet	*Number*	*Board feet*		
1	Beerkeg 2 and 3	Spielman, Art, Mar. 4, 1926.							

1. INTRODUCTION

The purposes of this plan are:

(1) To bring together all the available data concerning this circle that are necessary for the institution of forest management.

(2) To determine the time, place, and amount of cutting that will best carry out the policies of the Government in managing its forests; and to place the area on a sustained yield basis.

(3) To establish a permanent timber business centering largely around the town of Woodland Park, Colo.

The working circle is not being overcut. On the contrary, an immediate increase of about 30 per cent in the annual output and still other increases later are possible under the policy of sustained yield, and are desirable. The urgent need is to arrange for orderly and systematic cutting by a stable industry, in place of sporadic, scattered operations accompanied by poor marketing.

2. DESCRIPTION OF CIRCLE

(A) LOCATION AND SIZE

The circle is located in townships 10 to 13 south, ranges 68 to 70 west, sixth principal meridian, partly in each of Teller, Douglas, and El Paso Counties. On the south, east, and west it is bounded by ridge crests and on the north by Thunder Butte Mountain, low ridges and rugged canyons, all of which, as determined by actual practice in past years, limit the feasible hauling distance.

The total area within the national forest boundaries is 117,575 acres, of which 93,520 acres is national forest land. See "Status."

(B) TOPOGRAPHY

The surface is rolling to broken, being cut by numerous streams. Portions of four drainage basins are involved; namely, Turkey, West, and Trout Creeks, which flow northerly, and Fountain Creek, which flows southerly. Thus the circle includes the headwaters of several small streams and part of the divide between the South Platte and the Arkansas drainages. The elevation ranges from 7,500 feet on the north to 10,000 feet on the south, with four-fifths of the total area beween 8,000 feet and 9,000 feet.

(C) CLIMATE

The growing season is from June 1 to September 1. The total annual precipitation is between 20 and 30 inches and the major portion of it falls during the months of April, May, July, and August. Snow to a depth of 2 to 3 feet accumulates on north exposures during the winter. Ordinarily, logging operations can be conducted yearlong, although great seasonal extremes of moisture and temperature are characteristic of the area.

(D) SOIL

The soil is loamy gravel resulting largely from the breaking down of the Pikes Peak granite into a coarse gravel. The soil on limited areas in Manitou Park is of limestone and red-bed origin.

(E) STATUS AND LAND EXCHANGE

There are approximately 24,055 acres of privately owned lands widely scattered throughout the circle and within the forest boundary. Many of these holdings are unoccupied, but some are used to a limited extent for farming and grazing. They are so scattered that little attention need be given them at this time in connection with the management of the timber resource. It is estimated that approximately 15,000 acres of these private holdings will eventually be acquired, largely through tripartite exchanges. This will be slow, but some progress is already being made in accordance with a definite plan.

In addition, there are 46,000 acres of private lands within the circle and outside the forest boundary. These are made up of numerous small holdings, and although principally forested, are used to a limited extent for farming and grazing. They are mostly cut over and about 75 per cent now support thrifty immature stands. The balance is natural grass or cultivated land.

There are no mineral values in the area and very few mining claims.

3. ECONOMIC SITUATION

(A) POPULATION

The total population of the area, including the towns of Woodland Park and Divide, is about 500. Approximately 150 of these people live on the widely scattered private holdings. Woodland Park is 20 miles northwest of Colorado Springs, which has a population of 30,000.

(B) TRANSPORTATION

The Midland Terminal Railway, a short line extending from Colorado Springs to Cripple Creek, taps the southern portion of the circle. From Woodland Park via this road it is 20 miles to Colorado Springs and 30 miles to the Cripple Creek mining district.

As a whole, the circle is well provided with roads suitable for motor transportation, which radiate in a fairly satisfactory manner from Woodland Park. The Pikes Peak-Ocean-to-Ocean Highway parallels the railroad across the area. Extending north from Woodland Park is a good county road to West Creek, near the northern limits of the circle, with feeders satisfactory for motor truck use. Easterly from Woodland Park are the Mount Herman and Bald Mountain roads, also suitable for motor trucks. The northwestern portion of the area is crossed by the Lake George-West Creek Road, while the Divide Transfer Road skirts along the southwest side.

(C) LOCAL INDUSTRIES

There are few purely local wood-using industries at present. The town of Woodlawn Park is supported largely by ranching, farming, logging, and tourist travel. The head-lettuce industry has been receiving considerable attention in the locality during recent years and has to have crates.

Such timber business as is being conducted is in a chaotic state, each operator working with no definite plan. About a score are so engaged part time, supplying ties to the Midland Terminal Railway, lumber for local demands, mine props for the Cripple Creek district, and coal props for the regional mines. This situation has existed for the last 40 years and cutting has been widely scattered. Even until recent years Forest Service sales have been unsystematic, in that the location of cutting areas has been largely governed by the desires of the operators.

In the past there have been 15 to 20 small operators purchasing timber in amounts of $100 or less. These operators have so cut the price of timber products that the timber business at present shows little or no profit.

It is the responsibility of the Forest Service in the interest of the community and of good forest practice to stabilize and extend the timber business at Woodland Park in order that this activity may be well organized and may be operated at the highest speed consistent with the supply of raw material and permanency. Woodland Park is the logical center around which such a business should be developed. Most of the railroad ties for the Midland Terminal are now delivered at that point.

(D) LABOR

Expansion of the timber business to the capacity of the circle will give full-time employment to local labor, which is now only partially employed. Little or no outside labor will be required.

(E) MARKETS

The products of this working circle are being marketed unsystematically and inefficiently. The Colorado Springs lumber yards are not being used as an outlet for sawed material because they want finished and graded lumber. A list of the consumers of timber products from this circle in 1925 is given on page 61. The cut is about 1,000,000 board feet annually. In order to utilize the annual cut desired, it will be necessary to expand this market. The best way to do this appears to be to work along the following lines:

Establishment of a central finishing and distributing plant at Woodland Park.

Increasing the use of local lumber in markets now supplied from other sources.

Development of the manufacture of such by-products as box shooks, vegetable crates, laths, etc.

Increasing the use of small material for mine props, fence posts, etc. Treated fence posts should find a ready market in eastern Colorado.

Markets and uses within the working circle are very limited and will always be amply provided for by the carrying out of this plan.

A further opportunity exists in developing and meeting the demand for ornamental planting stock and Christmas trees, which can be obtained as thinnings.

4. FOREST DESCRIPTION

(A) TYPES

The western yellow pine and Douglas fir types are intermingled, cover about 90 per cent of the forested area, and contain about that percentage of the present merchantable volume. Western yellow pine predominates on south and west exposures and Douglas fir on north and east exposures throughout the circle, though usually there is no sharp line of demarkation between the two. The total of these two types might be divided roughly, by acreage and volume, into 60 per cent western yellow pine and 40 per cent Douglas fir. For most administrative purposes, it is unnecessary to separate the two types; they can be logged together for lumber, ties, mine props, etc.

Lodgepole pine, Engelmann and blue spruce, and limber pine constitute the remaining 10 per cent of the total forested area. Small areas of the Engelmann spruce type occur in the southern portion of the circle in the vicinity of The Crags, as isolated clumps along gulch bottoms, and occasionally on north slopes in the vicinity of Signal Butte. A fringe of lodgepole pine occurs along the eastern edge of the circle in the vicinity of Saylor Park. Blue spruce and limber pine occur as small groups or occasional trees throughout the circle.

(B) AGE CLASSES

Information regarding age classes is rather meager, though, generally speaking, all classes are fairly well represented, with the major portion of the area falling in the mature to overmature class. Reproduction is good over the area as a whole. Studies indicate than an average of four permanent seedlings per acre come in each year on cut-over areas in the western yellow pine type. (See p. 63.) Most of the unstocked acreage is in the form of old burns, slowly reseeding.

(C) PLANTING

Aside from a few experimental areas, no planting has been done within the circle. Estimates indicate that there are 10,610 acres in need of planting. Present plans contemplate planting 1,000 acres within the next five years as a part of the Mount Herman planting project, which is now under way. The balance of the area shown as in need of planting is in several widely seperated areas. The largest of these are Turkey and Trail Creek burns. It is very probable that all of them will be planted within the next 25 years.

(D) PROTECTION

The fire hazard is not great. The total acreage burned over during the last five years is almost negligible, being approximately 45 acres, or about 9 acres per year. This five-year period includes 1924, one of the worst fire seasons on record.

Mistletoe is present in western yellow pine throughout the circle. It is not serious, however. Provision for doing what is possible to control this disease is included in the marking-policy statement.

There has been no serious outbreak of insects. A few scattered trees infested with beetles (Dendroctonus) are to be found. Provision for control is likewise made in the marking-policy statement.

(E) GROWTH AND YIELD

Detailed data on growth and yield are very incomplete. The figures used herein were derived from an analysis of timber estimates and are believed to be conservative.

Slowness and lack of uniformity are the outstanding features of growth in this region. Excluding stagnant stands, the average d. b. h. at 80 years is 8 inches and at 160 years 18 inches. This is generally true for all species except lodgepole pine, which rarely attains 18 inches d. b. h. It is believed that western yellow pine and Douglas fir make more rapid growth as individual trees here than does any other species. This is to be expected on this circle, which is better suited for pine and fir than for other species.

The possible average annual increment is estimated at about 87 board feet per acre. However, much of this is now offset by overmaturity, windfall, and disease. The net usable annual increment of merchantable material is estimated to be 45 board feet per acre. In time, as utilization becomes more intensive, the net increment will approach more nearly the 87 board feet. (Basis for these figures will be found on p. 63.)

Any growth on the 34,190 acres of mature stands is balanced by decay and death. Of the remaining national forest area, 10,610 acres can become productive only by being planted. This leaves 48,720 acres of actual growing stands, which are estimated to have an annual increment of at least 45 board feet per acre, or a total annual increment of 2,192,400 board feet. If the open acreage is planted during the first cutting cycle and the areas of mature and overmature timber are cut over, the average net annual increment at the end of the first cutting cycle might be figured on this basis at 3,439,125 board feet; for it is logical to assume that growth on the 34,190 acres containing mature and overmature timber will amount to 45 feet per acre as soon as cutting takes place.

Summary of volume and acreage by age classes

Age class	National-forest acreage	Volume			Available to cut now	Volume available to cut now			Total reduced to board measure
		Saw timber	Ties	Props		Saw timber	Ties	Props	
		Board feet	*Number*	*Linear feet*	*Per cent*	*Board feet*	*Number*	*Linear feet*	*Board feet*
Mature and overmature	34,190	27,016,000	256,000	11,512,000	75	20,232,000	192,000	8,634,000	34,626,000
Intermediate; mature in 40 to 80 years	22,860	17,200,000	223,000	23,860,000	25	4,300,000	56,000	5,965,000	11,945,000
Poles; mature in 80 to 120 years	16,020	14,065,000	184,000	10,630,000	[1] 15	2,110,000	28,000	1,595,000	4,445,000
Reproduction; mature in 120 to 160 years	9,840	5,270,000	136,000	4,750,000	[1] 10	527,000	14,000	475,000	1,422,000
Burns not restocking	10,610								
Total	93,520	63,551,000	799,000	50,752,000		27,169,000	290,000	16,669,000	52,438,000

[1] From scattered, overmature trees in these stands.

These data are based largely on ocular estimates of stands by the district ranger, checked by comparisons with areas covered by intensive timber surveys. At best, the volumes and acreages indicated are only approximations, but they are believed to be sufficiently accurate for the present. Errors, if material, are on the side of safety.

5. MANAGEMENT POLICY

OBJECTS OF MANAGEMENT

(1) To produce the maximum volume of timber products under sustained yield and ultimately to establish a productive forest on every acre of potential timberland, by planting, fire protection, and regulation of cutting.

(2) To build up a stabilized logging business centering at Woodland Park.

(3) To acquire eventually all potential forest lands within the forest boundary that are chiefly valuable for national forest purposes but are now privately owned.

(4) To cooperate with owners of private forest land, both inside and outside the present forest boundary and within the Woodland circle, in managing the forests in the manner contemplated for national forest land.

(5) To market the maximum allowable amount of timber products, including as large a proportion of saw logs as is consistent with cutting at maturity. Site condition has a profound effect upon the size of any individual tree at maturity. One tree growing in a favorable situation may produce good saw timber in 160 years, while another tree of the same age, perhaps only a few feet away, may produce only railroad ties or mine props. In harvesting the crop all trees will be removed when mature and used for the product for which they are individually suited. Efforts will be made in marking to put the stand in shape for the greatest production of saw timber possible, as this product is the most useful now and will become of increasing importance in the future. Efforts will be made to develop markets in accordance with the discussion under markets.

(6) To maintain and improve the watershed protective effect of the forest, in order to safeguard the supply of water for the domestic and irrigation needs of local ranchers and residents and for the municipal requirements of Denver and Colorado Springs. A large portion of the circle drains to the reservoirs or intakes of the water systems of these two cities. The system of cutting will provide ample protection for all watershed values.

(7) To utilize forage resources in so far as this will not interfere with proper timber production. Grazing uses of potential timberland will be restricted or prohibited where such uses are detrimental to tree growth and natural restocking. A systematic study is being conducted to determine what, if any, damage is done by regulated grazing.

(8) To maintain the attractiveness of important scenic and recreational areas, such as The Crags and Crystola summer-home group in the southern portion of the circle, as provided for under "Marking-policy statement." The necessity, however, of providing sawmill sites and roads and banking grounds on individual logging units will be kept in mind in all recreational development. Essential outlets for timber will not be blocked. These points will be explained fully to all prospective applicants for special use privilege.

6. SILVICULTURAL POLICY

(A) OBJECTIVE

All cutting will be directed toward placing the forest in the best possible silvicultural condition by the removal of mature, overmature, diseased, and insect-infested trees, and inferior species, and by making improvement thinnings in immature stands.

(B) MARKING

All marking will be in conformity with the marking-policy statement for the forest.

(c) Studies along the following lines are under way or contemplated:

(1) Determination of increment in cut-over stands, all types.
(2) Determination of increment in young stands, all types.
(3) Determination of commercial maturity of important species.
(4) Data for stand and volume tables.
(5) Rate of natural reproduction in cut-over and virgin stands.
(6) Effects of grazing on reproduction and plantations.
(7) Thinnings in young natural stands.
(8) Thinnings in plantations.

7. REGULATION

(A) ROTATION AND CUTTING CYCLES

The rotation is set at 160 years, since at this age the stand will, according to present knowledge, produce the most satisfactory amount of saw timber and a considerable quantity of railroad ties and mine props. A longer rotation would involve holding trees beyond maturity.

Four cutting cycles of 40 years each are adopted, since it is assumed that cuts can be made profitably at the end of each 40 years. The data upon which these cycles are based are meager and will be checked by the studies contemplated.

(B) ALLOWABLE CUT

The tentative cut is based on the following premises: The total volume available now for cutting is 52,438,000 board feet, largely in mature and overmature stands which have no net increment. This amount will be cut during the first cycle of 40 years. The allowable annual cut indicated during the first cycle is 1,311,000 board feet. Approximately 1,000,000 of this annual cut will come from mature and overmature stands and 300,000 board feet as salvage from stands of the other three age classes. The recommended limitation of cut for the decade 1926–1935 is therefore 13,110,000 board feet or its equivalent in all forms of material.

This average annual cut of 1,311,000 board feet is a conservative figure, since it merely prorates the present estimated volume of old timber, less the volume reserved in marking, over the first cutting cycle without allowance for additions to that volume through the growth to maturity of trees in stands previously cut over. Revisions of this plan later in the present cutting cycle will contain better data and will almost certainly increase the allowable cut on the basis of more accurate and higher estimates. Furthermore, no allowance has been made for the volume of any material which it may prove feasible to cut in thinning immature stands, nor for volume which would now be wasted in cutting but which could be saved under better utilization, following improvement in markets.

(C) SELECTION OF CUTTING AREAS

The areas for cutting during the first budget period have been selected upon the basis of accessibility of the timber and its maturity. In general, it will be the plan to begin cutting in the south and east portions of the circle and progress northerly and westerly in counter-clockwise fashion, in so far as this is economically feasible, during the remainder of the first cutting cycle. All sales business will follow this general plan. In the larger bodies advertised sales will be made first, followed by small commercial sales, sales at cost, and free use, cleaning up isolated clumps, the aim being to put each unit into the best possible condition. After this standard has been attained, such areas will not ordinarily be cut again for 40 years.

8. TIMBER-SALE POLICY

(A) COORDINATING MARKETS AND MILLING OPERATIONS

The first step in management is to stabilize the present markets and the operations supplying them. This is to be accomplished by:

(1) Encouraging better working relations between producers and consumers.
(2) Encouraging installation of new and modern portable sawmill machinery in order that well-manufactured lumber may be produced.
(3) Cooperation with operators in extending their markets.

The second step is to establish new markets. The opportunities for this are covered under markets.

(B) SIZE, NUMBER, AND DISTRIBUTION OF SALES

Lumbering in this working circle must be done by small sawmill units. A large mill with logging railroad transportation from woods to mill could not be maintained. The aim will be to have a few full-time sawmill operations run by responsible men. It is recognized that one fair-sized operation, even of portable sawmill size, could utilize the full allowable cut of the circle. If such an operation is not established, the aim will be to divide the cut among not more than three smaller operations, each having a total average annual output of not more than the equivalent of 400,000 board feet.

Because of the limitation imposed by the cutting budget, the restricted market, and the lack of stability in the timber business smaller sales will be discouraged and demands for products from the circle diverted as far as practicable to the established operations. This should tend to stabilize the industry. The industry will be further stabilized through competition tending to eliminate inefficient purchasers and through refusal to make sales to those who have failed to comply satisfactorily with the provisions of previous timber-sale contracts.

(C) FREE USE AND SALES AT COST

Ordinarily only dead standing and down timber and green aspen will be granted under free use. Such use will be confined so far as possible to clean-up work on areas where commercial sales have previously been made.

Sales at cost are ordinarily for small amounts, and as far as practicable will be located on the numerous small and widely scattered patches of timber that can not readily be handled by commercial operations. The demand is small.

(D) LOGGING METHODS

All logging will be done by means of animals or motor trucks. The working circle is unsuited for any other methods of logging.

(E) SPECIFIC REQUIREMENTS

Sales business will be handled in such a manner as to be consistent with the policy stated in the Forest Management Handbook and the points brought out previously in this plan. It will be the aim to require the removal of all classes of products (logs, railroad ties, mine props) on sale areas. Until such time as all the products can be marketed, entire units will be withheld from sale. Exceptions to this policy will be made only with the approval of the district forester.

9. CUTTING BUDGET (1926 TO 1935)

As far as practicable the areas will be cut in the order listed in the cutting budget. The total estimated volume to be cut and the proportion of the various products approximate the calculated limitation of cut for the decade. Exact coincidence is not necessary and, in view of the quality of the estimates for several units, would not hold good when the timber is cut. Further, it is often impossible to determine in advance of actual sale whether certain trees or logs will be used for saw timber or for hewn ties or large mine timbers.

10. REVISION OF PLAN

A program of work begun in 1924 by the district ranger provides for timber surveys by units and compartments. This should be completed by 1935, at which time the plan will be revised on the basis of the new estimates.

Any changes or revisions must have the approval of the supervisor, district forester, and forester before they become effective.

No reproduction of the map which forms a part of the original of this plan is thought necessary as part of this publication. The principles involved are well illustrated by the map for the Custer working circle, Harney National Forest.

APPENDIX, WOODLAND WORKING CIRCLE

Consumers of timber products, 1925

Consumer	Lumber	Hewn ties	Props	Stulls and piling	Reduced	Wood
	Board feet	*Number*	*Linear feet*	*Linear feet*	*Board feet*	*Cords*
Cog road		2,500			75,000	
Carlton mines, Cripple Creek	81,800		9,800	6,400	104,400	
Pikes Peak Fuel Co			187,016		187,016	12
Midland Terminal Railway	[1] 29,403	10,043			330,693	
County commissioners, El Paso				6,400	12,800	
County commissioners, Teller				3,200	6,400	
County commissioners, Lincoln				3,200	6,400	
Denver & Rio Grande R. R		7,200			216,000	
Granite mines, Victor			8,000		8,000	
Portland mine	84,000		5,000		89,000	
City coal mines, Colorado Springs			10,000		10,000	
Rocky Mountain Fuel Co			10,000		10,000	
Crown mine, Marshall, Colo			15,000		15,000	
Acme mine, Louisville	12,000				12,000	
Citizens of Colorado Springs						500
Total	207,203	19,743	244,816	19,200	1,082,709	512

[1] In the form of sawed ties.

STAND TABLES

TABLE 1.—*A 10-acre plot, chiefly Douglas-fir type*

[In T. 10 S., R. 68 W.]

D. b. h.	Cut, per acre				Left, per acre				
	Douglas fir	Limber pine	Western yellow pine	Engelmann spruce	Douglas fir	Limber pine	Western yellow pine	Engelmann spruce	Total
Seedlings					50.0	4.0	12.0	23.0	89.0
Saplings up to 6 inches					47.0	7.0	23.0	25.0	102.0
6					8.4	1.1	3.9	2.7	16.1
7					6.1	1.1	2.0	1.8	11.0
8					6.9	1.3	1.2	.9	10.3
9					5.0	.8	1.3	1.3	8.4
10					6.1	1.5	1.3	.7	9.6
11		0.5			.4	.7		1.0	2.6
12	3.2	.3			1.4	1.0	.3	.4	6.6
13	2.2	.2	1.0		1.1	.4		.2	5.1
14	1.9	.4	.6	0.4	.7	.2		.1	4.3
15	2.5	.1	.7	.1					3.4
16	1.3	.2	.5	.2					2.2
17	1.4	.2	.4	.2					2.2
18	.9		.2	.1					1.2
19	1.1	.1	.3	.1					1.6
20	.4		.3						.7
21	.2		.2						.4
22	.3	.1		.4					.8
Total	15.4	2.1	4.2	1.5	133.1	19.1	45.0	57.1	277.5

Total all trees cut, 23.2

TABLE 2.—*Stand per acre, intermingled Douglas fir and western yellow-pine types*

[Based on strip surveys aggregating 42 acres, and estimate of individual trees, Turkey Creek unit No. 2, T. 10 S., R. 70 W.]

Kind of timber	Volume cut				Volume left						
	Trees	Saw timber	Ties	Total reduced to	Trees	Saw timber	Ties	Total reduced to	Poles, 6 to 10 inches	Saplings	Seedlings
	Number	*Board feet*	*Number*	*Board feet*	*Number*	*Board feet*	*Number*	*Board feet*	*Number*	*Number*	*Number*
Western yellow pine	11	1,105	13.3	1,504	12	57	14	477	12	45	25
Douglas fir	10	545	15.2	1,001	9	0	7	210	10	35	35
Total	21	1,650	28.5	2,505	21	57	21	687	22	80	60

TABLE 3.—*Stand per acre, intermingled Douglas fir and western yellow-pine types*

[Based on strip surveys aggregating 30 acres, Turkey Creek unit No. 1, T. 10 S., R. 70 W.]

Kind of timber	Volume cut				Volume left						
	Trees	Saw timber	Ties	Total reduced to	Trees	Saw timber	Ties	Total reduced to	Poles, 6 to 10 inches	Saplings	Seedlings
	Number	*Board feet*	*Number*	*Board feet*	*Number*	*Board feet*	*Number*	*Board feet*	*Number*	*Number*	*Number*
Western yellow pine	13	880	8.9	1,147	7	20	8.7	281	7	25	30
Douglas fir	10	505	11.9	862	4	0	4.2	126	6	23	34
Total	23	1,385	20.8	2,009	11	20	12.9	407	13	48	64

TABLE 4.—*Stand per acre, intermingled Douglas fir and western yellow-pine types*

[Based on strip surveys aggregating 80 acres, Fern Creek unit No. 1, T. 10 S., R. 69 W.]

Species	Volume cut		Volume left				
	Trees	Board feet	Trees	Board feet	Poles	Saplings	Seedlings
	Number		*Number*				
Western yellow pine	11.0	1,647	6.5	255	9.0	45	30
Douglas fir	8.5	739	7.4	205	13.5	50	20
Engelmann spruce	.1	14	.1	5	.1	5	----------
Total	19.6	2,400	14.0	465	22.6	100	50

TABLE 5.—*Stand per acre in mixed type of Engelmann spruce, limber pine, and Douglas fir*

[Based on strip surveys aggregating 12 acres, Catamount Creek unit, T. 13 S., R. 69 W.]

Kind of timber	Volume cut				Volume left						
	Trees	Saw timber	Ties	Total	Trees	Saw timber	Ties	Total	Poles 6 to 10 inches	Saplings	Seedlings
	Number	*Board feet*	*Number*	*Board feet*	*Number*	*Board feet*	*Number*	*Board feet*			
Engelmann spruce	8	326	8.9	593	7.6	4	5.9	181	15	80	175
Limber pine	9.8	236	8.9	502	14.9	110	5.4	272	30	515	255
Douglas fir	3.8	169	3.1	262	6.6	137	3.0	227	5	10	15
Total	21.6	731	20.9	1,357	29.1	251	14.3	680	50	605	445

GROWTH

A summary of growth experiments in heavy Douglas fir and Engelmann spruce, conducted by the Fremont experiment station, indicates a mean annual increment of 175 board feet per acre. This is the total increment. It is probable that the total increment on the average acre in the Woodland circle is about 87 board feet (half of the Fremont figure). But, because of waste in logging and from natural causes, it is probable that the figure of 45 more nearly approaches the annual marketable growth per acre.

TABLE 6.—*Growth in Douglas fir virgin stands RS, Mc–4, Fremont Experiment Station*

[The figures are for the period of seven years, 1916–1923. Location T. 14 S., R. 68 W.]

Data	Douglas fir	Engelmann spruce	Western yellow pine	Limber pine	Aspen	All species
Number of trees, 1916	362	460	3	57	236	1,118
Average d. b. h., 1916	7.09	2.98	4.30	3.91	2.23	4.68
Average d. b. h., 1923	7.37	3.23	4.42	3.99	2.49	4.99
Volume cubic feet, 1916 (gross)	1,950.5	336.4	3.76	82.46	70.96	2,444
Gross volume cubic feet, 1923	2,119.7	400.2	3.95	81.12	69.48	2,674
Gross volume increment per acre annum	29.6	9.4	.03	.92	1.66	41.6
Net volume increment (gross less dead) per acre annum	27.2	9.1	.03	−.19	−.07	33
Per cent increase gross volume per acre annum	1.5	2.8	.8	1.1	2.3	1.7
Per cent increase, net volume per acre annum	1.4	2.7	.8	−.2	−.1	1.35

Since the plot is 0.918 acre, the growth figures of all species, when increased to an acreage basis, show that 45.32 cubic feet is the gross increment and 35.94 cubic feet is the net increment per acre annum.

The plot was laid out in a north slope stand of Douglas fir at an elevation of 9,100 feet at the Fremont Experiment Station. The mature stand is 265 years old and 78 per cent is Douglas fir over 6 inches d. b. h. An understory of poles and saplings about 70 per cent Engelmann spruce, is present. Reproduction seems to be balanced between Douglas fir and Engelmann spruce. The site conditions are good.

TABLE 7.—*Rate of natural reproduction, cut-over western yellow pine*

[Location, sec. 28, T. 10 S., R. 69 W. One acre plot established 1916, cut over 1915, recounted 1923 and 1926]

	Trees	Volume	Per cent by volume
	Number	*Board feet*	
Original stand	123	5,630	100
Cut	34	3,065	54.4
Left	89	2,565	45.6

REPRODUCTION

Year counted	Under 1 foot		1 to 4½ feet		4½ feet to 3½ inches, d. b. h.		Total
	Western yellow pine	Douglas fir	Western yellow pine	Douglas fir	Western yellow pine	Douglas fir	
1916	50	10	88	4	70	1	223
1923	74	9	80	6	88	3	260
1926	29	8	68	6	81	2	194

This represents a total increase of 37 trees in seven years, or 5.3 per year. The loss shown in the 1926 count is due to the drought of 1924 and 1925.

CALCULATION OF THE MEAN ANNUAL INCREMENT

The present lack of adequate or reliable data makes impossible any accurate determination of growth. For the purposes of this plan a rough calculation is made, which can stand as conservative until a better basis is obtained.

The available data consist of stand tables derived from a number of timber surveys and the summary of experiments carried on at the Fremont experiment station. The former lacks accuracy, but gives a rough estimate of what has grown in the past; the latter deals only with the total increment laid on, with no reference to future merchantable increment, but serves as a valuable check on the former.

The calculation of increment is approached from three different angles—a theoretical analysis based on growth in virgin stands, the probable second cut on present timber sales, and a reduction of Bates's and Roeser's figures from total increment to merchantable increment. These are considered in order.

1. The basis for this discussion is the summary of the timber-survey stand tables, which show that the average acre of virgin forest is composed, in rounded-off figures, of:

	Trees to cut 10 inches and over	Trees to leave 10 inches and over	Poles 6 to 10 inches	Saplings	Seedlings
Number	30	21	43	141	106
Volume	3,040	930			

It is assumed that the 30 trees designated to cut range in age between 160 and 300 years, or, in other words, between the average ages of maturity and death. The 160 has been accepted for years as approximately correct; the 300 is based on studies made by W. J. Pearce (Journal of Forestry, April, 1920), which have been checked by the judgment of the writer.

These 30 trees represent the average maximum number of trees over 160 years old that the average acre of virgin forest can sustain constantly. This is evident if the virgin forest is conceived to be a finely balanced organization

of age classes. The number of trees passing into any age class depends on the number in the next lower age class, which is in turn dependent on the extent of competition by larger trees in the upper age classes. Thus there are no more mature trees than every age class below can produce in mature trees. If the balance is overthrown by some agency, such as fire or insects, and a larger number of mature trees is produced by any one age class, then the lower classes will suffer by competition and produce a smaller number. In time the balance will be restored.

2. The timber-survey stand tables given above show that 21 trees 10 inches and over are left in the first cutting. It is estimated that in 40 years they will be ready for cutting. Assuming that their net volume per tree will be equal to that of the present veterans, or 102 board feet, the stand ready to cut in 40 years will be 2,142 board feet. From the 50 poles, 6 to 10 inches d. b. h., now present, 21 should have moved into the next class.

Thus the mean annual increment is about 54 board feet per acre.

3. The summary of the Fremont growth experiments shows that the average total increment in heavy Douglas fir and Engelmann spruce on a good site is about 175 board feet per acre. Half of this figure, or 87 board feet, would closely approach the total increment on the average acre of timber type for the whole forest. Much of this total is lost through decay, death, and incomplete utilization. Thus the available increment is in the neighborhood of from 40 to 50 board feet. As markets become better, with consequent closer utilization and thinnings, the total increment will be approached more nearly by the volume removed.

In other words, about every 3.3 years an old veteran dies, and of the number of seedlings taking its place only one will reach 300 years. In each of the six 50-year classes of the virgin forests there are 15 mature or eventually mature trees, totaling 90 on an acre at any one time.

Under forest management the forest will not run the full gamut of 300 years. When the timber reaches 160 years of age (or as soon after that as logging is practicable) it will be cut. Thus there will be four 40-year age classes instead of six 50-year classes.

A mature tree of 160 years is about the equal of a veteran of 300 years in net volume (gross minus rot and defect), crown space, and root space. Consequently the number of mature or eventually mature trees in the 300-year stand (90) will be the same as in the 160-year stand. This number will be distributed over four age classes, since every mature tree needs one in each age class that will supplant it. Thus there will be 22.5 trees reaching maturity each 40 years, providing a cut is made each cycle. At 102 board feet per tree the increment per acre would be 2,300 board feet in 40 years. The mean annual increment is 57.5 board feet.

CONCLUSIONS

The above calculations, while at best only approximations, point to an average annual increment of 55 board feet per acre. Notestein (Naturita management plan, 1912) found that the mean annual increment in western yellow pine on the Naturita division of the Montezuma National Forest was 38 board feet per acre. Considering all types, growth on the Woodland circle is better than this, but it must be remembered that the 93,520 acres over which the 55 board feet would be applied contain many acres of very low productive capacity.

Accepting 45 board feet as a conservative minimum, the present annual increment for the circle is about 2,200,000 board feet accruing on 48,720 acres of immature stands, eliminating 34,190 acres of virgin timber on which the net increment is negligible and 10,610 acres of unstocked land. After these virgin mature stands are cut over and the burns are planted, the total acreage of timber type, 93,520 acres, will be putting on its full increment, or approximately 4,208,000 board feet.

EXTRACTS FROM THE MARKING POLICY STATEMENT FOR THE PIKE NATIONAL FOREST ESPECIALLY APPLICABLE TO THE WOODLAND WORKING CIRCLE

General basis of management.—Generally speaking, trees should be marked for cutting as nearly as possible at the time when the mean annual growth begins to fall off. This does not coincide with diameter growth; for even when

the growth rings get narrower the tree may still be putting on more increment than when the tree was smaller and growth rings wider. It is important not to confuse the two, because in general a larger proportion of desirable and valuable products are secured from the larger trees. But when increment ceases to increase satisfactorily, the tree has reached commercial maturity and ordinarily should be harvested. "Maturity" throughout this statement is used with this meaning.

The following tabulation, based on the local volume table for Engelmann spruce, illustrates this point and will be found helpful in determining the maturity of any tree:

Number of rings in outside inch required to maintain uniform rate of volume increment in the tree

D. b. h. (inches)	Number of rings per inch required to show a growth rate of 5 board feet per year	Number of rings per inch required to show a growth rate of 1 cubic foot per year	D. b. h. (inches)	Number of rings per inch required to show a growth rate of 5 board feet per year	Number of rings per inch required to show a growth rate of 1 cubic foot per year
6			20	20	17
8		3	22	24	19
10	4	6	24	27	21
12	7	10	26	30	23
14	11	13	28	33	25
16	14	15	30	36	28
18	17	16	32	40	30

The point at which commercial maturity is attained varies with species, site, and market requirements. Some stands are commercially mature at prop size, others at railroad-tie size, while still others, possibly of the same species, can be most profitably held for saw-timber production. Each stand is a problem in itself and requires special consideration and skill on the part of the marker if the desired results are to be attained. The marker should examine each tree closely and his conclusions should be based on external appearances, checked sufficiently by use of the increment borer.

Conditions on the ground, after cutting and brush disposal are completed, are what count. This principle should be kept in mind in determining the marking policy for a given sale, and sacrifice should be made in stumpage rather than in desirable silvicultural practice.

MARKING PRACTICE

Marking in all types will follow the selection system. Only in clearly defined cases where different treatment is justified because of fire or wind damage, insect injury, disease or decadence, or stagnation beyond point of recovery, will this practice be departed from. The object in all marking is to harvest the commercially mature and overmature timber and to remove defective, diseased, or overcrowded trees in the younger age classes.

Diameter guides.—Diameter guides are intended merely to give forest officers inexperienced in marking in a given type of timber a general idea of the average sizes at which the different species reach commercial maturity. These guides are not intended to be applied mechanically, and care will be necessary to see that marking officers understand their application. The size at which maturity is reached will vary widely with conditions of site and growth, and marking must be based upon a close examination of each tree.

Vary marking.—One of the chief faults in marking practice is failure to change the marking when the character of the stand changes. In passing from a thrifty mature stand to a pole or overmature stand the marking must change abruptly. On ridges and otherwise poor sites, trees virtually stop growing at smaller diameters than on good sites, and the marking must vary accordingly.

Defects of various kinds often furnish sufficient reason for taking out trees that are approaching maturity or certain trees located in stands where there is an opportunity to practice selection. However, the same defects occurring on younger trees may not be of sufficient importance to warrant their removal

before the next cut. The marker will also be less exacting regarding defects in considering trees along the edges of openings or in parks or in any other location where a tree is badly needed for seed or for otherwise assisting in extending the forest.

Forked and leaning trees.—Trees will not be marked for cutting merely because of a fork or slight lean. However, they should ordinarily be marked, even though immature, if they have forks so located that an appreciably greater quantity of the more valuable products will never be produced. Forks of certain types split off or allow the entrance of disease. Knowledge of local timber will indicate the need for marking trees with forks of a character subject to such damage.

Unless a tree leans to the extent that it will possibly fall before a second cut, or lose in value through distortion, or unless it is likely to rub or distort another tree, it will not be marked merely because of the lean.

Basal fire scars.—Basal fire scars are found on several species and are most important on lodgepole pine and yellow pine. The damage done on individual trees depends upon the size and character of the scar. In a great many cases, particularly in yellow pine, the scars have become pitched over and consequently have little or no bearing on the need for marking the tree. Marking will be done because of scars only when the scars are really serious defects, retarding growth or threatening the life of the trees.

The policy in yellow pine will be to mark only such immature trees showing these defects as have been so severely burned as to be reduced to shells, so that they can not be expected to make satisfactory growth. However, basal fire scars on all species should be examined critically, because if any rot exists, the tree should invariably be marked.

Canker.—Canker infections are important in lodgepole pine, for breakage takes place and fungous diseases gain entrance at the point of infection. Trees with the larger, more serious infections, should be marked; but trees with small cankers—unimportant from the above standpoint—should be marked only when they can be removed as a thinning measure.

Mistletoe-infected trees.—Mistletoe attacks a number of species, but is of most frequent occurrence in this district on lodgepole pine and yellow pine. Heavily infected trees are characterized by a general appearance of unthriftiness; poor, thin crowns; sickly, pale-colored, and often short needles; distorted branches, frequently dead or dying; and the presence of witches brooms.

As far as possible, all infected trees should be marked for cutting. Some stands are so heavily infected that it is impossible to get rid of all the mistletoe without practically clear cutting. In most lodgepole stands this treatment is proper. In yellow pine this same treatment will be warranted in seriously infected stands provided there is advance reproduction or sufficient seed trees remaining to restock the area. However, in the yellow-pine type care should be exercised not to carry this policy to the extreme of marking thrifty, immature trees having minor infections which manifestly will have little or no effect on tree growth or on the spread of the parasite.

Insect infestations.—The subject of insect infestations is too large to cover in detail. Infestations of any consequence should be promptly reported, with a view to undertaking special control measures without delay in all cases where conditions warrant.

On the other hand, there is opportunity to reduce insect damage of a minor nature and eliminate the infestation before it becomes serious through intelligently directing the regular marking practice. Bark beetles cause the most serious damage, and it is important that trees containing them be marked for cutting and utilized before the broods emerge.

Western yellow-pine type.—Saw timber will ordinarily be the major product obtained in the management of this type. An exception may be made in the case of occasional stands on steep slopes where saw-timber operations are not feasible, or of isolated stands too small in area to justify a portable-mill setting. Such stands may be handled for hewed ties.

Thrifty, middle-aged, and young trees will be left as a basis for a second cut and for seed distribution. Trees in the "black-jack" stage and thrifty "intermediate" trees will not be cut unless they contain defects sufficient to warrant their removal. Discretion must be exercised in marking immature trees on account of defects—trees in openings or along the edge of openings should be left, even though the defects they contain would warrant cutting if they were located in normally dense stands. Trees with thin or flattened crowns are ordi-

narily growing slowly and belong to the mature or decadent class. Such trees should be cut unless they are needed for seeding purposes. Marking will usually remove from 65 to 75 per cent of the merchantable volume of the stand in trees 10 inches d. b. h. and over, though the percentage must be determined by the condition of the stand.

In some instances the stands along the upper slopes and crests of ridges are composed mainly of large, poorly formed trees, most of which should be cut from the standpoint of maturity. However, these trees, by reason of their commanding position, are valuably situated as seed trees, and a sufficient number should be left in these situations to provide ample seed insurance.

Hewed ties.—On the very limited areas of this type, chiefly on poor sites, which will be managed on a hewed-tie basis, trees 13 inches d. b. h. and over will be considered mature, and unless needed for seed or protection will be marked. Trees below this size will be marked only when, on account of defect, it will not pay to leave them for the next cut.

Dougas fir type.—Saw timber and hewed railroad ties are the major products to be obtained from this type. By limiting cutting to trees which are commercially mature and to thinnings, thrifty stands of well-formed Douglas fir, occurring on favorable sites, will be allowed to grow to saw-timber size. However, a great deal of Douglas fir occurs in isolated patches or on steep or rocky slopes where saw-timber production will be impracticable. Such stands will be cut on the basis of maximum production of hewed railroad ties, even though this means cutting some trees before volume growth culminates.

Clear cutting would practically never be justified in this type. Because of the great variation in Douglas fir saw-timber stands it is impossible to suggest any diameter guides that would be helpful in marking. The ideal way to mark this type would be to remove trees that are commercially mature, making improvement thinnings, the products being marketed in the form of saw logs, railroad ties, and mine props. This is merely the selection system. In many cases such close utilization is impossible, but this ideal should be approached as closely as economic conditions permit.

Where market conditions permit, crowded stands of immature poles will be thinned from below for the production of mine ties, mine props, telephone poles, or other small-sized products. See discussion, under "Thinning."

Douglas fir is also the climax type on many areas now supporting stands of other species, such as lodgepole pine. A very conservative policy will be followed in removing Douglas fir from such stands.

Engelmann spruce type.—This type is especially well adapted to the selection system of cutting. Saw logs will be the most important product obtained and this should constantly be kept in mind. Trees that are mature and those that are diseased or seriously defective should be marked. Care should be exercised in marking not to be influenced by the increasing market that is developing for railroad ties of this species. If not guarded against, this tendency to be influenced by the market might result in marking immature trees of this species to a greater extent than defect, disease, or a desirable thinning warrants.

Usually a sufficiently dense stand of young and middle-aged trees will remain after cutting to protect itself against windthrow. If trees much taller than the new canopy are left, they will afford little or no additional protection to the remaining stand and are the ones most likely to blow down. Accordingly, care should be taken not to leave tall trees, the crowns of which will extend much above the general crown level of the stand remaining after cutting.

Approximately 60 per cent of the merchantable volume of the stand will be removed by following this policy.

Mixed types.—Mixed types will be marked in the manner prescribed for the major species involved. Small patches of a different species within areas where railroad ties are being produced, but where sawmills are not planned on at the time of the next cut, will be marked on the same principles as the rest of the sale area. This is illustrated by Engelmann spruce occurring in patches on north slopes or in strips along streams within a lodgepole pine stand that is adapted to the production of hewed ties.

Marking to favor more desirable species.—Occasional stands are found in which the overstory of merchantable timber is of a different and less desirable species than the understory. An example is a stand of blue spruce with an understory of Douglas fir, or a stand of decadent lodgepole that is coming up to Engelmann spruce. In such cases it is permissible and advisable to mark

the overstory more heavily than would be the practice if this species were to remain the dominant one in the stand and form the basis for future cuts. On sites where several species occur in mixture, the more desirable species will be favored.

Inferior species.—White fir and alpine fir are inferior species, the removal of which is desirable in all types. Except in extensive pure stands of these species, all trees of merchantable size will be cut, which means that utilization of all trees at least 10 inches d. b. h. and larger will be required. The policy will be to withhold from the market any areas on which the percentage of these species is so large that an operator can not or will not utilize them. Until conditions become such that all inferior species, marked as outlined, can be utilized, applicants will all be directed to areas where the percentage of such species is so low that they can be handled.

GENERAL MARKING CONSIDERATIONS

Thinning.—Stands of immature timber that are too dense to permit of proper development occur in nearly all types. These stands may occur as pole stands covering considerable areas or as small patches or clumps within areas of older timber. In either case it is good silviculture to thin these stands by removing sufficient trees to provide room for the remainder of the young stand to develop. The extent to which thinning can be practiced depends almost entirely upon the class of products that the markets can absorb. At present we are unable to conduct operations in many stands of small sized timber where thinnings are silviculturally desirable.

In general, thinnings will be made from below. That is, the poorer and usually crowded or partially suppressed trees will be taken to make room for the better individuals. Where, through natural survival of the fittest, a few trees in the group have attained dominance and the others are more or less badly crowded so that their response to release is questionable, it is obviously poor practice to mark the larger trees to make room for the poorer ones. These larger trees are reaching the point where they are making the most valuable and rapid growth and to cut these to free doubtful trees will detract from the yield obtainable in the next cut. In making thinnings, the aim should be to attain ample and approximately equal spacing in the stand left on the ground.

Christmas-tree cutting of Douglas fir.—Christmas trees will be cut only from stands that are in actual need of thinning. The production of Christmas trees will never be the ultimate objective in managing any national forest timber. Such trees will be harvested only as by-products from thinnings designed to improve the stand and facilitate the eventual production of commercial timber.

Cutting on Christmas-tree areas will be done only by forest officers or cutters working under the immediate supervision of forest officers.

No very definite rules governing thinning can be established, as the degree of thinning depends upon the size and condition of the trees in the stand. The general aim is to leave thrifty, well-formed trees, as well spaced as possible, and with crowns completely freed. Spacing will vary usually from 8 by 8 feet to as much as 16 by 16 feet. The number of trees left per acre will of course vary in proportion to the spacing attained.

Timber cutting on scenic areas.—Around the more important areas used, or likely to be used, extensively for recreation, the policy will be to make an improvement cutting removing dead, insect-infested, and diseased trees, and only such other trees in need of removal as can be spared without marring the beauty of the setting.

Along highways the standard marking policy should not be varied if sufficient timber will remain to insure a forested appearance on the area. It is very desirable for the public to see forestry in practice. However, in case the character of the stand is such that under the regular marking policy only scattered seed trees will be left for any great distance along a road, trees of a character ordinarily marked for cutting will be reserved to the extent necessary to avoid leaving areas that have a denuded appearance.

On camp and summer-home sites shade is an important feature, and unless marking according to the standard practice will result in adequate shade on such areas sufficient trees will be left for this purpose. As far as possible the additional trees should be those that will last over until the next cutting.

Administration

Marking percentage in contracts.—Forest officers preparing timber-sale contracts should not be influenced by the natural desire of operators to secure the greatest volume possible. The percentage stated in each contract should be based on conditions on the ground and application of the marking practice to the particular area.

Leaving saw-log trees.—Stands will not be cut over in such a way as to take material for hewed railroad ties or other products and leave saw-log trees, except with the specific approval of the district forester.

Checking up marking.—Regular inspection of the marking just in advance of the cutting presents an excellent opportunity to catch up trees overlooked in marking, and every advantage should be taken of this.

General.—It is the duty of those in charge to see that the various officers understand the principles and interpret and apply the instructions uniformly. One standard should hold for the entire forest. Men newly assigned to marking should not be allowed to mark independently until sufficient timber has been marked with them to insure their getting a thorough knowledge of the work before they are turned loose.

The above plan will govern all marking. Additions or modifications will be approved by the district forester before being made effective.

A. G. Hamel,
Forest Supervisor.

Approved February 1, 1926.

M. W. Thompson,
Assistant District Forester.

MANAGEMENT PLAN FOR THE RIO PUEBLO WORKING CIRCLE, CARSON NATIONAL FOREST, N. MEX.

Respectfully submitted.

Fred H. Miller,
Forest Assistant.

Approved October 16, 1923.

Earl W. Loveridge,
Forest Supervisor.

Approved June 9, 1924.

R. E. Marsh,
Acting District Forester.

Approved September 3, 1924.

E. A. Sherman,
Acting Forester.

I. FOUNDATION

1. INTRODUCTION

The Rio Pueblo working circle covers the forested portion of the Rio Pueblo watershed, which is located in the extreme southern end of the Taos division of the Carson National Forest. The watershed is formed by the Rio Pueblo and the Santa Barbara Creek, which flow together, forming Embudo Creek. Embudo Creek in turn flows into the Rio Grande at the settlement of Embudo.

The area is a natural logging unit; for high surrounding ridges preclude the possibility of removing timber in any way except down the valley bottoms.

At present complete control by the Forest Service of the timber stands in the working circle is not possible because of the presence of the Santa Barbara grant, which is owned by the Santa Fe Railway interests and covers an area equivalent to 23 per cent of the total, and of an area along the east boundary of the working circle, the ownership of which is in dispute between the Mora grant and the United States. The latter territory comprises about 18 per cent of the total area. Hereafter in this report it will be referred to as the disputed strip.

The management plan is based on the eventual acquisition of the Santa Barbara grant by the United States, and also on the acquisition of the disputed

strip in case an adverse decision is handed down by the supreme court. The successful carrying out of the plan depends upon such acquisition.[7]

The data used in the preparation of the plan have been obtained from various sources. The topographic and type maps were made from timber reconnaissance field work and are considered good. The estimates for cut-over land have been built up on an average acre basis for each type. Field data were secured by calipering large areas within each type. These estimates are considered reliable. The estimates for the mature virgin stands were likewise arrived at on an average acre basis. It was found by check estimates that the original reconnaissance figures were worthless. Accordingly, a revision was made on the basis mentioned. Growth and yield figures are based on Korstian's work and on recent investigations. All available data have been included in a report, "Growth and yield data for the important timber species in northern New Mexico" on file in the offices of the supervisor and district forester.

The plan will be sufficient for a period of 10 years. At the expiration of the decade (1933) it should be revised.

2. PHYSIOGRAPHIC FEATURES OF THE AREA

(*a*) *Size and location.*—The Rio Pueblo is one of the important tributaries of the Rio Grande in northern New Mexico. The watershed is located in Taos County, approximately 20 miles south of Taos on the west slope of the Sangre de Cristo Range of the Rocky Mountains. The forested area of the watershed, all within the Carson National Forest, the Santa Barbara grant, and the disputed strip amounts to 110,385 acres.

(*b*) *Topography.*—The topography is very rough. Elevations range from 7,500 to 13,000 feet above sea level. The main drainage is to the west, with many side tributaries cutting deep canyons in the mountain side. The entire working circle is a series of canyons and ridges with comparatively small areas of level or gently sloping land in the canyon bottoms or on the ridges. The rough country makes this logging chance a most difficult one from the operator's viewpoint.

(*c*) *Climate.*—Because of the high elevation an abundance of rainfall is precipitated upon this area. No exact figures on annual rainfall are available, but on the basis of the records of stations situated in somewhat similar localities it is estimated that the Rio Pueblo country receives about 26 inches annually. Most of the rain falls in summer during July and August. The snows commence in October or November and cover the ground until April. Some drifts on north slopes and in sheltered ravines do not disappear until July. Showers in April, May, and June are not uncommon, so the fire danger during that period is not so pronounced as is usual in the Southwest.

Killing frosts sometimes occur as late as June 1 and as early as September 15. The area receives an abundance of rainfall but has a short growing season.

(*d*) *Soil.*—In general, the soil is a shallow clay loam with a range from slide rock to a deep clay in the canyon bottoms.

3. FOREST DESCRIPTION

(*a*) *Types present.*—Elevations range from 7,500 feet on the west up to 13,000 feet on the south and east. Accordingly, all of the important timber types in the southern Rocky Mountain region are present, namely, Western yellow pine, from 7,500 to 9,000 feet; Douglas fir, from 9,000 to 10,000 feet; and spruce, from 10,000 feet to timber line at 11,500 feet.

Of the total productive timber area of 52,865 acres the pine type covers 11,987 acres, the Douglas fir type 17,889 acres, and the spruce type 22,989 acres.

(*b*) *Major silvical features.*—With the exception of the yellow-pine type, in which groups of all ages occur, the forest is practically even aged. Within a Douglas fir or spruce stand, however, there is an even distribution of diameter classes, due to various degrees of suppression, which in effect gives the forest an all-aged appearance. It has been observed in old cuttings that after the stand has been opened by felling the larger trees a marked increase in growth takes place in the formerly suppressed or partially suppressed trees. Therefore, in

[7] Laws authorizing the exchange of national forest timber or land for these areas were enacted in 1925 and 1926, respectively, following a decision against the United States in the case of the disputed strip.

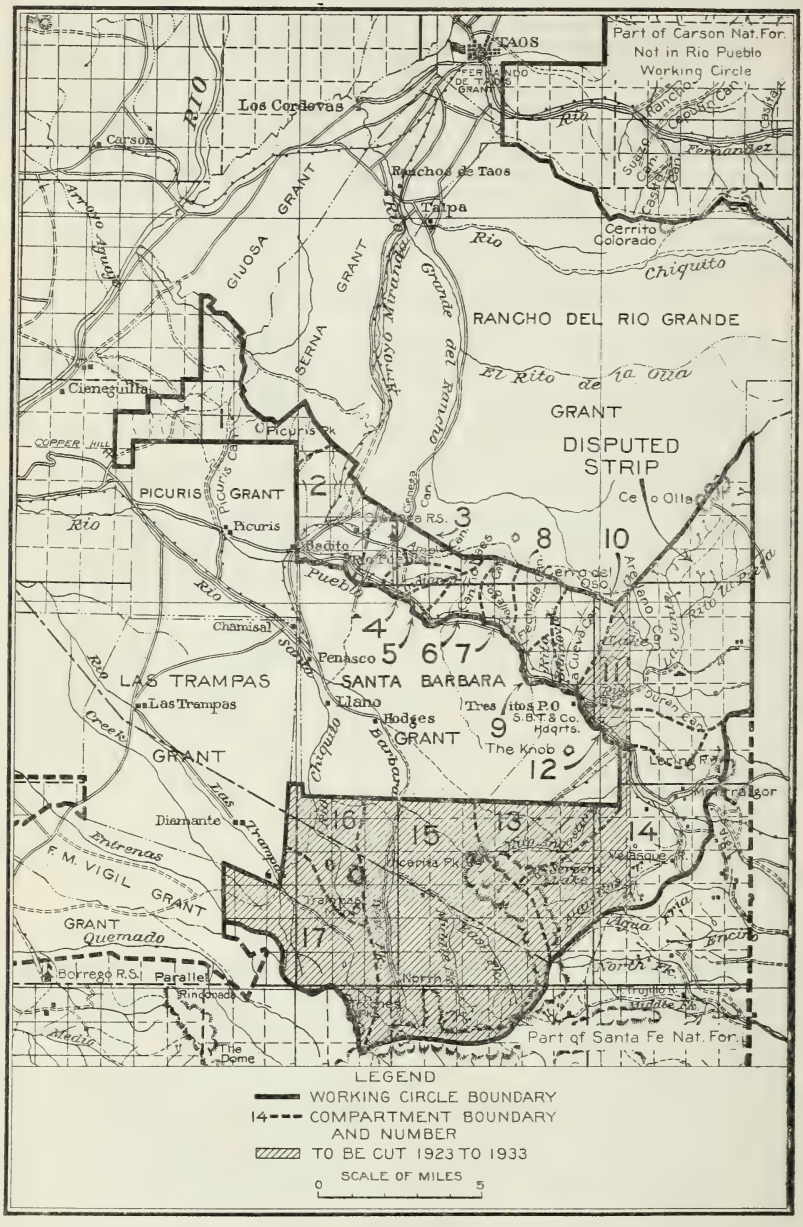

FIG. 3.—Pueblo working circle, Carson National Forest, N. Mex.

the yellow-pine type a group-selection system of marking is applicable. In the two higher types a straight-selection system, guided by a diameter limit, has been in use and has been found effective.

Advanced reproduction is well established over the entire area, so that barring fires or insect attacks, a fully stocked stand for the second rotation is assured. In the yellow-pine type, pine reproduction predominates. Therefore, the stand during the second rotation will be identical with the original forest.

In the Douglas fir stands, white-fir reproduction greatly outnumbers the small Douglas fir. In such stands it has been the practice to make rather heavy openings. On the theory that Douglas fir will outstrip its associate white fir in the race for dominancy where given full top light. This theory has never been proved correct and further observations are necessary before exact knowledge can be available. However, it is the writer's opinion that if a stand is cut when a d. b. h. of 15 inches is attained, the percentage of white fir in the replacement stand will be much greater than it was in the original stand, in which Douglas fir has gained the upper hand as a result of its longer life. (White fir is very susceptible to a heart rot which causes rapid deteriorating in trees over 16 inches d. b. h.)

The same condition is found in the spruce type, in which cork-bark fir seedlings far outnumber the more desirable Engelmann spruce. In this case, likewise, it is thought that cork-bar fir will form a large percentage of the stand if it is cut on a short rotation basis, as is contemplated.

The stand of poles and saplings left after the first cut in the original forest is largely made up of the more desirable Douglas fir in the former type and Engelmann spruce in the latter. The range of diameter classes is sufficiently large to provide a cut of species in about the same proportion as occurred in the virgin stand for at least the next two cutting cycles. The change in the composition of the stand will not occur until the present advanced reproduction reaches merchantable size, which will be in about 90 years.

At the present time about half of the forest area is classed as nonproductive. Much of the area included within this nonproductive classification is stocked with immature timber. In the true sense of the word the area is not unproductive, but it carries no mature stands, hence has not entered into the calculation of yield for the first cutting cycle. In the drafting of future plans this area will play an important part.

(*c*) *Situation as to fire.*—During recent years there have been no large fires within the spruce stands. In the past great fires have swept over portions of this area and killed every tree. Probably the old fires ran through stands which had been killed or at least weakened by some pest, such as the spruce bud worm.

Following logging the resulting débris naturally creates a big risk.

Fire starting from lightning is the greatest danger. However, carelessness on the part of the employees of operators may possibly be the cause of a fire's getting loose.

The smokestacks on each of the mills are amply guarded with spark arresters, and little or no danger is anticipated from that source.

The burning of slab piles must be carried on with the greatest care, but this danger is fully appreciated, and proper precautions are being taken to prevent the escape of fire.

A good automobile road from Taos to Las Vegas is now being built through the working circle. When the road is completed there may be some danger from campers being careless with fire.

The comparatively large amount of rainfall, the frequency of showers during the summer, and the long period during which snow lies on the ground combine to make the danger from fire in the Rio Pueblo working circle as small as in any stand in the national forests of Arizona and New Mexico.

(*d*) *Growth and yield.*—Studies to determine the average rate of growth of the most important individual species found in the area have been carried on. The results of these investigations are found in the report the "Growth and yield data of the important timber species in northern New Mexico."

In formulating the plan of management it is necessary to know the average number of years required to produce a 14-inch tree. The following figures are taken from Tables 8, 10, and 12 of the report above referred to to produce trees of 14-inch d. b. h.: Western yellow pine, 120 years; Douglas fir, 146 years; Engelmann spruce, 115 years.

If full data were available, it would probably be found that a different rotation ought, theoretically, to be adopted for each type. Full data are not available, but average relationships between age and d. b. h., without differentiation of types, have been determined from a limited number of stump analyses. The trees selected for measurement were not picked for good crown development, but were taken at random as found in the woods after a felling crew. Furthermore, comparatively few trees were used in each determination. For the present it is safe to assume that tie-sized trees will be produced in 140 years in all types; and that period will be considered as the rotation.

Within all types in the virgin stand there is a good representation of all diameter classes. Accordingly when the mature trees are removed from the virgin stand in the first cut there is left a large number of small trees per acre. For stand tables giving the average number of trees left per acre after cutting see Tables 5, 6, and 7 of the "Growth and yield" report.

After the removal of the larger trees from the virgin stand the remaining trees are able to get more light and moisture, and their rate of growth is stimulated. For detailed figures giving rate of growth per decade after cutting and in the virgin stand refer to Tables 19, 20, and 21 of that report.

By applying the rate of growth per decade to the number of trees per acre in each diameter class one is able to predict the number of trees in each diameter class at stated intervals following cutting.

By applying a volume table to the trees in each class the total volume of the stand per average acre at different periods following the cut can be predicted.

The table given below shows the yield per acre for each type for three decades following cutting of the original stand:

TABLE 1.—*Yield per acre for each of three types*

	Pine type		Douglas fir type		Spruce type		
	Board ft.	*Ties*	*Board ft.*	*Ties*	*Board ft.*	*Ties*	*6 by 6 ties* [1]
TEN YEARS AFTER CUTTING VIRGIN STAND							
10 years after first cut	3,025	87.38	2,795	69.64	4,985	44.11	163.10
Left after first cut	2,266	69.42	2,035	49.59	2,915	18.97	95.40
Available to cut	759	17.96	760	20.05	2,070	25.14	67.70
TWENTY YEARS AFTER CUTTING VIRGIN STAND							
20 years after first cut	4,011	106.75	3,801	96.10	7,664	86.84	244.52
Left after first cut	2,266	69.42	2,035	49.59	2,915	18.97	95.40
Available to cut	1,745	37.33	1,766	46.51	4,749	67.87	149.12
THIRTY YEARS AFTER CUTTING VIRGIN STAND							
30 years after first cut	5,208	132.64	5,169	129.84	11,059	141.67	342.85
Left after first cut	2,266	69.42	2,035	49.59	2,915	18.79	95.40
Available to cut	2,942	63.22	3,134	80.25	8,144	122.88	247.45

[1] Ties of this size are not now marketable. The figures indicate the possible cut of mine props or of other small material, if a market is found.

(*e*) *Summarized tables.*—

TABLE 2.—*Area classification of Rio Pueblo watershed*

		Acres
Gross		110,385
Alienated:		
Disputed strip	19,754	
Homestead-entry surveys	190	
Santa Barbara grant	25,784	
Total alienated		45,728
Net		64,657

TABLE 3.—*Classification and ownership of timber on Rio Pueblo watershed*

	Area				
	United States	Disputed strip	Homesteads	Santa Barbara grant	Total
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Productive timber area	30,336	8,302	52	14,175	52,865
Nonproductive timber area [1]	34,321	11,452	138	11,609	57,520
Total	64,657	19,754	190	25,784	110,385

[1] Includes inaccessible, scattered and immature timber, woodland, aspen, grass, burn, burn restocking, barren, and cultivated. Immature timber is that which can not be cut for at least 30 years, and hence is not considered in planning cutting operations during the first cutting cycle.

TABLE 4.—*Classification of productive timber area by types and ownership*

[For detailed classification see area tables in appendix]

Type	Area of timber owned				
	United States	Disputed strip	Homesteads	Santa Barbara grant	Total
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Pine	7,426	292	52	4,217	11,987
Douglas fir	8,214	3,708	----------	5,967	17,889
Spruce	14,696	4,302	----------	3,991	22,989
Total	30,336	8,302	52	14,175	52,865

TABLE 5.—*Summary of estimates as of December 31, 1923*

[For detailed estimates see tables in appendix]

Type	United States land				Alienated			Total
	Cut over [1]	Virgin		Total	Cut over	Virgin, accessible	Total	
		Accessible	Inaccessible					
	M board feet	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*	*M board feet*
Pine	9,805	11,264	9,100	30,169	7,949	1,523	9,472	39,641
Douglas fir	6,586	24,903	4,671	36,160	11,582	13,927	25,509	61,669
Spruce	8,967	87,869	15,500	112,336	6,999	31,021	38,020	150,356
Total	25,358	124,036	29,271	178,665	26,530	46,471	73,001	251,666

[1] The estimates given for cut-over lands show the volume left immediately after logging. No allowance for increment has been made.

	Board feet
Total accessible virgin timber	170,507,000
Total accessible cut-over timber	51,888,000
Total accessible timber	222,395,000

(*f*) *Status.*—The Santa Barbara grant, owned by the Santa Fe Railroad through a subsidiary corporation, comprises a total area of 31,084 acres. Of this, 5,300 acres were set aside by decree No. 960, Taos County, for settlement. The balance, 25,784 acres (23.3 per cent of the gross area of the working circle) is not suited for agricultural development and will always be forest land. With the exception of a few isolated spruce stands the grant has been cut over by the Santa Barbara Tie & Pole Co.

Since the grant is wholly within the working circle it would be of great advantage for the Government to acquire this land in order to consolidate the forest area. The owners are favorably inclined toward exchanging title of this land for an equal value in stumpage. Steps are already under way toward bringing the exchange to a head. Incidentally, the areas logged in 1908 can now be cut for the second time. Accordingly, early acquisition by the United States would help immensely toward better control of the timber stands within the working circle.

The location of the west boundary of the Mora grant has been disputed between the owners (the State Investment Co.), and the United States for a number of years. An area of 19,754 acres within this working circle is involved in this dispute.

A very small area within the working circle has been alienated under the homestead laws. Only 190 acres along stream bottoms have been taken up by settlers. This area represents about the maximum acreage of tillable land available. No further settlement is possible.

To sum up, about two-fifths of the total area of the working circle is in private ownership. Unless the Government can get control of these alienated lands (except the agricultural lands) administrative problems in connection with a plan of management will be very difficult.

4. ECONOMIC SITUATION

(*a*) *Population.*—The area included within the working circle is nonagricultural, with the exception of a few farms located along the canyon bottoms, which support about 50 people. Farther to the west, in the lower country but within the same watershed, there are more farms. All of the agricultural lands have long been settled by Indians and Mexicans. The main settlements center around Hodges, Penasco, and the Picuris Pueblo. There are about 3,000 people in this vicinity.

East of the Rio Pueblo watershed and separated from it by the Arkansas-Rio Grande divide is the comparatively large fertile Mora Valley, which extends from Chacon in a southeasterly direction through the villages of Holman, Cleveland, and Mora to Las Vegas. About 12,000 people, all Mexicans, inhabit this valley. The city of Las Vegas is not included in this estimate of population.

Taos Valley, to the north, centering in the town of Taos, the county seat of Taos County, supports a native Indian and Mexican population of about 5,000 people.

(*b*) *Labor supply.*—There is an abundant local labor supply.

The local native population in the three valleys mentioned above are all farmers. The demands of their small farms keep them busy for a short period each year, and they need other work during the other months. The returns from their ranches are barely enough to sustain life, and without an outside source of revenue these people have practically no money. Many of them supplement the income from their crops by raising a few head of cattle, sheep, or goats, which are grazed on adjacent forest ranges. Practically all of the men seek outside employment for a certain period each year. Some go to the mines near Raton, others work as laborers on the railroads, and still others seek employment with the lumber operators near by.

An additional source of labor is furnished by natives of Mexico, who continually drift into the United States. The timber operators prefer this class of labor, for these peons are usually skilled tie hackers, and, furthermore, they are more reliable, since they have no near-by homes to return to whenever a few dollars have been earned.

(*c*) *Transportation.*—The narrow-gauge Santa Fe branch of the Denver & Rio Grande Western Railroad, with a station at Embudo, is the nearest railway to the working circle. Embudo is about 30 miles distant from the center of the timber area.

Because of rough topography, it is impracticable to build a branch railroad from Embudo to the logging unit. Therefore the operator must rely on driving his products downstream to a shipping point. This limits the products that can be marketed to ties, mine timbers, and similar forms of material.

A highway between Taos and Las Vegas passes through the working circle, but because of distance it is impracticable to haul forest products to either place.

(*d*) *Practical considerations—Markets.*—The lumber needs of the Rio Pueblo Valley do not exceed 25,000 board feet per year. More than enough side lumber will be manufactured from the exploitation of the tie timber in the working circle to supply this demand perpetually. In fact, the full utilization of side lumber will be a problem for many years to come because of the economic impracticability of getting it to a general market.

The inhabitants of the Mora Valley are not dependent on this working circle for their forest products. Their supply is gotten from the east slope of the range.

Neither is Taos Valley dependent on the Rio Pueblo timber. There is more than sufficient timber in the Taos drainage to supply the inhabitants with all their needs.

Because of the high cost of railroad construction due to difficult topography and because of the impossibility of driving logs down the small streams to supply a sawmill located at Embudo, the exploitation of the Rio Pueblo timber for lumber is not now economically feasible. Also, Engelmann spruce, cork-bark fir, and white fir are species which are not in favor for lumber production. A large percentage of the timber in the working circle is composed of these species. For this reason alone the stand is an unattractive chance for a large lumber operator.

There is a strong demand for crossties for the Santa Fe Railroad, which has absorbed the entire output of this area since 1908. The initial investment necessary to exploit a stand for ties is small. A large percentage of ties are hewn in the woods. All logs over 12 inches in diameter are taken to small portable mills and sawed into ties. Furthermore, ties are comparatively small, easily handled in rough country, and can successfully be driven in a stream the size of the Rio Pueblo.

There is no local demand to absorb the side lumber which could be cut in the small mills in producing ties. Accordingly, only enough is cut to supply construction needs in connection with the operation, and to supply near-by farmers who buy an occasional wagonload. The problem of marketing side lumber from the operation has been given much thought by the supervisor's office, but no solution has been found to date.

Mine timbers could be gotten to the shipping point as economically as ties. If a market developed for such material the utilization of unused tops and of thinnings, especially from the spruce stands, would add greatly to the forest revenue, as well as allowing the practice of better forestry from a silvicultural and utilization standpoint. Such a market does not now exist.

Besides the large volume of spruce and cork-bark fir, both excellent pulp woods, there is an area of 30,382 acres covered by a stand of aspen estimated to carry 300,000 cords. In case the White Rock Canyon dam is built in the Rio Grande there would be sufficient power generated to operate a large pulp mill, which could draw on the pulp stands in the upper Rio Grande drainage.

For the next decade it is unlikely that any markets other than the existing one for crossties will be developed. Nevertheless, in order to utilize all material fully it is absolutely necessary that this question of markets for pulp wood or mine timbers be kept in mind at all times. The most desirable form of forest management can not be practiced without an outlet for thinnings and unusued tops. Therefore it is up to forest officers on the ground to seize the first market opportunity that presents itself.

Logging and accessibility: It is possible to construct roads with steep grades into practically every canyon so that with the exception of isolated rocky areas of small extent the entire working circle is accessible.

The present plan of operation provides that all logs under 12 inches in diameter at the small end shall be hewn into ties in the woods. Large logs are sawed into ties. The small tributary canyons carry a flow of water for at least several months every year. Both sawed and hewn ties are flumed to the main Rio Pueblo, down which they are driven to Embudo, and thence down the Rio Grande to Domingo, the shipping point on the Santa Fe Railroad, a total driving distance of 95 miles.

Water: The Rio Pueblo watershed is one of the best watered regions of New Mexico. Permanent streams flow in all the main canyons and many of the branch streams carry a perpetual flow of water. This watershed is an important tributary of the Rio Grande and accordingly is of great value in conserving water for irrigation purposes.

Aside from the value of the watershed for irrigation purposes the flow of water in the Rio Pueblo is absolutely essential for driving forest products from the logging chance to the shipping point. In a normal year the deep snows at the high elevations begin to melt in April, and by the 1st of May the Rio Pueblo is in the high-water stage. It is at this time that the drive commences. Occasionally a winter deficient in snowfall results in a tie-up of the season's cut, due to lack of water on which to float the ties. Such a period of drought occurred in the winters of 1920–21 and 1921–22. A three-year cut of ties was driven to Domingo after the heavy snows of the winter of 1922–23.

II. MANAGEMENT PLAN

1. OBJECTS OF MANAGEMENT

(*a*) *Products.*—The forest will be managed to produce hewn ties. Sawn ties will also be manufactured because of the presence in the virgin stand of trees above hewing size. During the second cutting cycle sawn ties will also be produced but to a less extent. To meet this object of management it will be necessary to produce a tree 14 inches d. b. h.

Mine timbers from tops and thinnings to as great an extent as the market can consume will be produced as by-products.

(*b*) The plan is based on a sustained yield.

(*c*) Ties will be produced for the general market. Local markets will be supplied from side lumber produced as a by-product in the manufacture of sawn ties.

(*d*) It will be an object of management to furnish as steady employment as possible to the local population, whose small ranches and stock holdings are not sufficient to sustain families.

(*e*) The watershed will be protected through conservative methods of cutting and through protection from fire and grazing.

(*f*) Consolidation under Government ownership of the entire working circle will be sought through acquisition by land exchange of the Santa Barbara grant and the disputed strip.

2. SILVICULTURE

(*a*) *Policy.*—Since ties are the product to be grown, trees having a d. b. h. of 14 inches are ready for market. Therefore, all timber reaching that size, except a sufficient reservation for seed, can be cut. The composition of the stand is such that by removing all timber 14 inches d. b. h. and above there will remain a sufficient number of trees from the seedling to large pole stage to restock the area sufficiently.

Douglas-fir seed trees are to be reserved in the fir type in preference to white fir.

Engelmann-spruce seed trees will have the preference in the spruce type.

At least one large thrifty seed tree will be reserved per acre.

Since the stand left after the first cutting in the virgin forest is so dense that thinning would undoubtedly be of great advantage in accelerating growth and in view of the future market for mine timbers or pulpwood which would make such practice possible, some knowledge as to the effect of thinning in accelerating growth is needed in order to guide the officer working for a thinning. In order to be prepared with a definite marking policy for thinning in the Douglas fir and spruce types, sample plots should be established in those types as soon as possible.

(*b*) *Marking.*—Since a successful method of marking is now being followed in all types within this area no change from the present system is recommended. For all details reference is made to "Administrative instructions. S–Exchange, Carson. Santa Barbara Tie & Pole Co., June 30. 1922." (See Appendix.)

3. REGULATION

(*a*) *Policy.*—The forest is to be managed on a sustained annual-yield basis for the purpose of furnishing a continuous cut. A limitation of cut will be applied by decades, i. e., the annual cut may vary somewhat, but the calculated cut for the decade must not be exceeded, though it should be closely approached.

The sequence of cut will be so arranged that complete logging units will be cut out before operations are allowed to move to other units.

(*b*) *Rotation and cutting cycle.*—A technical rotation of 140 years has been determined as necessary to produce an average tree of 14 inches d. b. h. on all situations and within all types.

The cutting cycle, or time elapsing on a given area before the second cut, has been fixed as 30 years. This period allows 14 years, counting from January 1, 1924, within which to remove the balance of the virgin stand.

The annual cut during the second cutting cycle will exceed the average annual cut during the first period.

(c) *Determination of cut.*—After the completion of the exchange agreement now in force there will be a large volume of accessible virgin timber left within the working circle. The stand is distributed as follows:

	Board feet
United States	124,036,000
Disputed strip	36,812,000
Santa Barbara grant	9,659,000
Total	170,507,000

After reference to the preceding tables showing yield on cut-over areas 10, 20, and 30 years after logging it has been decided to allow 30 years to elapse on a given area after cutting before the second cut is to be made. In other words the cutting cycle will be 30 years.

The first cutting took place on the Santa Barbara grant in 1908. Since only tie timber was cut the operation left the area in good shape for a second cut. By 1924, when the exchange agreement will have been fulfilled, 16 years will have elapsed since the inception of the logging operation. Therefore 14 years remain during the first cutting cycle in which to remove the balance of the virgin stand.

The remaining accessible virgin stand on the Santa Barbara grant (9,659,000 board feet) will be disregarded since the timber occurs in small isolated stands, and it would not be considered good business management to move mills to each stand. Therefore, there is left 124,036,000 board feet on Government land and 36,812,000 board feet on the disputed strip, or a total of 160,848,000 board feet.

Even though the disputed strip is not controlled by the United States there is little doubt that this timber will be cut in its turn since the State Investment Co. is desirous of receiving some return from its lands. Assuming that this stand is to be cut over we have a total stand of 160,848,000 board feet. Approximately 67 per cent of this volume, or 107,768,000 board feet, can be cut. Distributing this cut over 14 years, the remaining period in the cutting cycle, we get an average annual cut of 7,698,000 board feet. The average annual cut for the past decade has been 7,350,000 board feet, including private land cuttings.

The fact that the Santa Barbara grant covers the most accessible territory within the working circle; that a small volume can now be logged as a second cut; and that the grant is owned by the present operating company, points to the possibility that the operation may be moved to grant land unless the proposed exchange goes through. If such a change in operating plans would occur, the carrying out of this plan without a hiatus would be impossible because it is extremely doubtful if an operator other than a subsidiary of the Santa Fe Railroad could be induced to tackle the proposition.

Assuming that the operation will be confined to virgin timber as long as it lasts, the virgin stand will have been cut over in 1938, and the stand cut over in 1908 will then be ripe for a second cut.

The allowable annual cut of 7,700,000 board feet applies to the period 1924–1937, inclusive, or for the remainder of the first cutting cycle. It is of interest to record the writer's prediction of the allowable annual cut during the second cutting cycle. This figure is obtained by multiplying the total number of productive acres in each type by the yield per acre after an elapse of 30 years, and then dividing this total volume by 30, the period of years in the second cutting cycle.

TABLE 6.—*Allowable annual cut during the second cutting cycle*

Type	Area	Available 30 years after original cut
	Acres	*Board feet*
Pine	11,987	35,266,000
Douglas fir	17,889	56,064,000
Spruce	22,989	187,222,000
Total	52,865	278,552,000

The total of 278,552,000 divided by 30 years equals 9,285,000 board-feet, the allowable annual cut during the second cutting cycle.

In addition to the above predicted cut, there are now about 1,000 acres of immature timber that will most likely mature within 30 to 60 years. Therefore as time goes on the allowable annual cut can be further increased. When a market for thinnings develops the rate of growth of the stands will be augmented and another increase in the allowed cut can no doubt be made.

Any unforeseen forest calamity, such as a big fire or a widespread insect infestation that kills the timber, will necessarily involve an immediate revision of the plan of management.

Summary

	Board feet
Allowable annual cut for balance of first cutting cycle	7,700,000
Predicted cut, second cutting cycle	9,285,000

4. SALES POLICY

The logging operation can best be conducted by one large concern. Although but little investment is needed for equipment, a very large working capital is necessary in order to finance a year's operation. Because of climatic conditions it is sometimes impossible to drive the product to market for two or even three years. Therefore, except for S–22 sales, but one large operator will be given a tie sale at one time, with the exception that small sales may be made in compartment 1, Picuris, an area considered inaccessible to the large operation because flumes can not be built into it.

In case a market for mine timbers or pulp wood develops, sale of these products should be made. No efforts should be spared in keeping the supply of such products before possible purchasers. The company getting out ties would be best able to handle this material; but if it should be unwilling to do so, another operator should be allowed to take the sale. If such a sale be made, a record of the material removed should be kept separate from the volume of ties, and not deducted from the allowable annual cut, for the reason that such material is now a waste product and has not entered into the calculation to determine the allowable annual cut.

Brush disposal.—The standard district three methods of brush disposal have been found as applicable to these areas as to any others in the district. Therefore reference is made to the following instructions, with no modifications:

(*a*) Pine type: "Standard instructions for brush disposal" September 21, 1918. Copy to be found in S–supervision standards of sale practice. Desk copy.

(*b*) Douglas-fir type: "Standard instructions for brush disposal" September 21, 1918. Copy to be found in S–supervision, standards of sale practice. Desk copy.

(*c*) Spruce type: Administrative instructions, S–exchange, Carson, Santa Barbara Tie & Pole Co., June 30, 1922. (See appendix.)

5. CUTTING BUDGET

The remaining virgin timber is to be cut in the following order:

Order of cutting	Compartment	Volume to cut	Probable date of completion of cutting
		Board feet	*Year*
1	Angostura No. 13 (now under exchange agreement)		1924
2	Alamitos No. 14	[1] 8,771,000 18,246,000	1927 1926
3	Agua Sarca No. 12	[1] 2,224,000	1927
4	La Junta No. 11	[1] 13,668,000	1929
5	Santa Barbara No. 15	33,500,000	1933
6	Rio Chiquito No. 16	9,798,000	1935
7	Las Trampas No. 17	21,560,000	1938
8	Return to stands cut over in 1908.		

[1] In disputed strip.

III. ADMINISTRATIVE CORRELATION

1. LAND EXCHANGE

As mentioned previously, the successful carrying out of this plan depends upon the acquisition of the Santa Barbara grant by the United States. In case the disputed strip is awarded to the State Investment Co., steps to acquire that area should be taken. In both cases it is believed that the owners would consider an exchange of title for stumpage. In case of an exchange agreement the stumpage within this working circle might well be offered. In case the owners of the Santa Barbara grant continue their tie operations, the value of stumpage can be credited directly against the cost of the land. If the operation is by another concern, arrangements could be made through a three-cornered agreement.

2. IMPROVEMENTS

No new road developments or other improvements are needed to open up the working circle.

3. GRAZING

Comparatively few sheep are now grazed within the working circle. Several bands are permitted on allotments within the high spruce type. Sheep damage to spruce reproduction is not so serious as within the pine type. The question of sheep damage is now before the local officers for study.

Every Mexican family along the canyon bottoms owns a band of goats—mostly exempt stock. The animals have been allowed to run at large on the forest. Most of these herds have had free access to the pine type, and considerable damage to pine seedlings has resulted. It is a difficult administrative problem to control these small bands of domestic goats, but the animals must be controlled in order to prevent further damage.

Exclusion of sheep within the cut-over pine areas in accordance with the district policy will be carried out.

4. RECREATION

No immediate development of recreational areas within the working circle is anticipated. Good trout streams are found in the area, so some camping parties from Las Vegas or Taos may camp along the streams for short periods each fishing season. No improvement work by developing camp grounds and no definite recreational plan is needed to take care of this use.

Scenic strips along roads have been provided for in marking instructions.

5. SALE ADMINISTRATION

1. Because of the short field season at this altitude and because of the fact that the majority of the future cutting will be on Government lands (heretofore about half of the company's annual cut has been on grant land), it may be impracticable for one man on the sale to attend to his routine duties and to keep enough timber marked ahead of the saws. Therefore, it may be advisable to put a marking crew into the field and mark out enough timber for a two-year cut.

2. The officer in charge of the sale will submit semiannually on July 1 and December 31, a report covering the costs of operation and the quantity of work turned out by each unit of production (saw crews, skidding team, hauling wagon, mills, etc.) as outlined in D. O. circular 57–S–4, May 24, 1922. A special effort should be made to determine the losses of ties due to "sinkers," breakage, and the escape of ties from the boom at Domingo, whenever a drive is made.

3. In addition to the progress map the officer in charge of the sale will keep a separate topographical map on which is shown the boundaries of all logging units, areas, or blocks. This map will be submitted to the supervisor January 1, annually, to be transcribed to the permanent office copy.

4. Scaling records will be kept separate for each compartment. When that compartment is completely cut over the officer in charge of the sale will submit a report to the supervisor showing the quantity cut therefrom.

5. Provision will be made to caliper annually, either the entire unit cut over during the previous year or else at least 40 acres of that area. The data will be needed as a basis for an estimate of cut-over land.

6. The progress of the cut will be brought to date in the timber-sale-atlas-control record by January 31 of each year.

7. A check on the accessible virgin stumpage in the Rio Chiquito and Las Trampas watersheds will be made at the first opportunity. If the correction estimate is at variance with the estimates given herein, the periodic cut will be adjusted accordingly.

8. This plan will be revised at least once by January 1, 1933.

6. PROTECTION

No unusual protection problems are involved in the management of the working circle. Methods of brush disposal and detection now in use will suffice to protect the area from fire damage.

IV. APPENDIX, RIO PUEBLO WORKING CIRCLE

The appendix in the plan as submitted contains, in addition to the tables and text given here, the following:

Detailed area classification.
Area classification by types and ownership.
Summary of accessible and inaccessible estimates.
Detailed estimates by compartments.

The summary of estimates has been rearranged.

TABLE 7.—*Acreage of accessible lands now producing merchantable timber and entering into the calculations on which the cut for the first cutting cycle is determined*

	United States land			Alienated land			Total areas			Per cent of gross area (110,385)
	Cut over [1]	Virgin	Total	Cut over	Virgin	Total	Cut over	Virgin	Total	
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	
Yellow pine	5,266	2,160	7,426	4,269	292	4,561	9,535	2,452	11,987	10.9
Douglas fir	3,984	4,230	8,214	7,007	2,668	9,675	10,991	6,898	17,889	16.2
Spruce	3,409	11,287	14,696	2,401	5,892	8,293	5,810	17,179	22,989	20.8
Total	12,659	17,677	30,336	13,677	8,852	22,529	26,336	26,529	52,865	47.9
Per cent of gross area (110,385)	11.5	16.0	27.5	12.4	8.0	20.4	23.9	24.0	47.9	

[1] To Dec. 31, 1923. (Includes total Angostura watershed.)

TABLE 8.—*Summary of all classes of land within the working circle*

Type	Productive		Nonproductive		Total	
	Acres	Per cent	Acres	Per cent	Acres	Per cent
Yellow pine	11,987	10.9	4,083	3.7	16,070	14.6
Douglas fir	17,889	16.2	1,835	1.6	19,724	17.9
Spruce	22,989	20.8	920	.8	23,909	21.6
Woodland			2,949	2.7	2,949	2.7
Aspen			30,382	27.5	30,382	27.5
Brush			1,250	1.1	1,250	1.1
Grassland			9,939	9.0	9,939	9.0
Burn			1,116	1.1	1,116	1.0
Burn restocking			4,363	4.0	4,363	4.0
Barren			103	.1	103	.1
Cultivated			580	.5	580	.5
Total	52,865	47.9	57,520	52.1	110,385	100.0

TABLE 9.—*Summary of estimates*[1]

[M feet, board measure]

Type	Virgin stands					Cut-over lands					Total
	United States acessible	Disputed strip	Santa Barbara grant	Total acessible	United States inaccessible	United States	Disputed strip	Santa Barbara grant	Homestead	Total	
Pine	11,264	1,523	----	12,787	9,100	9,805	----	7,852	97	17,754	39,641
Douglas fir	24.903	13,927	----	38,830	4,671	6,586	1,719	9,863	----	18,168	61,669
Spruce	87,869	21,362	9,659	118,890	15,500	8,967	----	6,999	----	15,966	150,356
Total	124,036	36,812	9,659	170,507	29,271	25,358	1,719	24,714	97	51,888	251,666

[1] As of Dec. 31, 1923. Angostura watershed considered as cut over. Estimates for cut-over lands are for condition immediately after cutting, with no allowance for growth.

METHODS USED IN ARRIVING AT ESTIMATES

Virgin stand.—The entire area within the working circle, except the Santa Barbara grant, was covered by a timber reconnaissance party between 1912 and 1914.

The estimates for the Santa Barbara watershed were made by Hadley and Meredith Jones, the logging engineer for the Santa Fe Railroad. They are used intact.

The volume of the virgin stands in the Rio Chiquito and Las Trampas areas was arrived at by applying the average volume per acre to the stocked areas gotten from the type map.

The average volume per acre for the three types is as follows: Pine type, 5,215 board feet; Douglas-fir type, 5,220 board feet; spruce type, 6,075 board feet.

Cut-over areas.—Stand tables were constructed from strip surveys, made in all types in the cut-over stand. The volume per average acre was gotten by applying the volume table to the stand. The total estimate was therefore arrived at by multiplying the number of acres cut over in each type by the volume per acre for that type.

See Tables 5, 6, and 7, in "Growth and yield data for the important timber species in northern New Mexico."

On the Picuris strip the total volume left, arrived at by the above method, equals 16,641,000 board feet. The volume left, arrived at by applying the per cent of volume left to the total cut, was 19,423,000. In order to be conservative the per acre basis method will be used.

The average stand on an acre immediately after cutting the virgin stand is for the pine type, 1,862 board feet, 12 inches and above; the Douglas-fir type, 1,653 board feet, 12 inches and above; and for the spruce type, 2,915 board feet, 10 inches and above.

INSTRUCTIONS REFERRING TO MARKING AND BRUSH DISPOSAL

[From administrative instructions dated June 30, 1922, in Santa Barbara exchange case]

Marking.—Since all yellow pine and Douglas-fir types on the exchange area have been marked, cut over, cleaned up, and accepted, the discussion here on marking will deal only with the pure alpine type, in which all cutting from the present to the end of the agreement will be done.

Description of type: Beginning at the northern extremity of the area along the boundary between the national forest and the Santa Barbara grant, average elevation 10,000 feet, the pure alpine type is well established, with very rarely an isolated Douglas fir or white fir. There are only three commercial species in this type—in order of their importance—Engelmann spruce (*Picea engelmanni*), 50 to 75 per cent; alpine fir (*Abies lasciocarpa*), 25 to 50 per cent; bristle-cone pine (*Pinus aristata*), 0.1 per cent. Advancing up the watershed from the north, 10,000 feet elevation, to the south, 12,000 feet elevation, Engelmann spruce increases from 50 to 75 per cent of the stand; alpine fir decreases from 50 to 25 per cent; tie timber increases from 50 to 75 per cent; and the stand changes from very uneven aged, with the ground more than fully stocked with reproduction on the lower end, to almost even aged, with little reproduction on the upper end of the area.

In order that the marking policy may be more clearly understood, the timber may be placed in subtypes, as follows (each subtype is treated separately):

(1) Uneven-aged stand—ground fully stocked with reproduction; at least 150 well-established saplings and poles per acre. Mark all alpine fir 12 inches d. b. h. and over having at least two ties. Mark all Engelmann spruce 14 inches d. b. h. and over having at least three ties, provided that marking to this extent will not reduce the crown cover to less than 50 per cent; otherwise, raise diameter limit to obtain a 50 per cent crown cover.

(2) Uneven-aged stand in groups surrounded by open park grasslands or aspen—ground fully stocked with reproduction on interior of groups. On interior of groups mark same as No. 1. Around outer edges of groups, leave well crowned two and three tie trees to seed up adjacent park areas and protect groups from wind throw, if there are not sufficient trees of pole size for this purpose. Isolated trees in parks should be left regardless of their size and condition.

(3) Uneven-aged stands not fully stocked with reproduction; mark as in (1) but maintain a 50 per cent ground cover by raising the diameter limit to 16 or 17 inches if necessary. This will insure sufficient seed supply.

(4) Even-aged stands fully stocked with reproduction; mark as in (1).

(5) Even-aged stands not fully stocked with reproduction; mark as in (3); maintenance of 50 per cent crown cover will insure sufficient seed trees.

According to the exchange agreement any tree having one 6 by 8 inch by 8 foot tie is merchantable; therefore, any diseased tree will be marked if one or more sound ties of this size can be made from it.

All merchantable bristle-cone pine trees will be marked.

The occasional white firs on the lower end of the area will not be marked, since the company does not have to cut them under the agreement and does not want them.

As a rule, large trees will not be left on the area to insure a supply of seed is case fire destroys the existing reproduction, since the fire resistance of these larger trees is no greater than that of those around 14 inches d. b. h. However, a few of these larger trees should be left along the main streams, as their chance of escaping a fire is good on such locations.

Because of the shallow-root systems of the species in the alpine type there is a real danger of wind throw in opening up stands on wind-swept ridges and isolated groups of timber. This should, therefore, be considered in marking timber under such conditions.

Often times a mixture of the above-described subtypes may occur, which brings out the point that these rules should not be followed blindly, but should be adjusted to meet conditions on the ground.

Protection.—Brush disposal, alpine fir and Engelmann spruce types, Angostura and Alamitos watersheds: In this type the brush resulting from all phases of the operations will be lopped close to the ground but not scattered. The stubs of branches left on bole will not exceed 6 inches in length. Seed trees over 18 inches d. b. h. when left will be protected by pulling away the brush to a distance of 15 feet from all sides of the tree. When the ground cover is dense, skid trails and logging roads will be left free of brush in order to preserve their value as fire lines. On open, steep hillsides not more than one out of every three of the main skid trails will be left clear of brush for this purpose. Brush should be scattered over the rest of these skid trails as a means of retarding erosion. The brush disposal should not be allowed to get more than two weeks behind the rest of the operation. This will probably require permanent brush crews.

Fire lines will consist of a strip 150 feet wide on which all brush and litter is piled and burned. They should, whenever possible, be located along log roads and skidways and must divide the cutting area up into blocks of not more than 80 acres. They should run across topography on slopes and along tops of ridges and bottoms of canyons.

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